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**An Exploration of the Potential of Complexity Theory
for Addressing the Limitations of Current Models of
Change and Innovation in Educational Practice.**

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Abstract

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In this thesis I argue that there are limitations inherent in many of the research projects undertaken within the traditions of school effectiveness and school improvement. These limitations, in my view, are in large part due to assumptions that change in schools is a linear process and that innovations can be introduced most effectively through rational planning and implementation. I argue that these assumptions may misrepresent the fundamentally dynamic and inherently unpredictable nature of many educational contexts. Complexity Theory appears to provide useful insights into such dynamic contexts elsewhere. This thesis explores the application of Complexity Theory to education.

A unique contribution of the work undertaken in this thesis is in the attempt to develop instruments and techniques of data collection and analysis to detect Complexity features. Research was carried out in three primary schools in a South Wales Local Education Authority where I work as an Education Adviser. Quantitative and qualitative data were utilized including interview and observational data integrated to form what I have called a 'Learning Episode'. In the longer term these are being used with teachers in a relatively non-judgemental and 'evolutionary' way whereby practitioners act to select and refine ideas from a published bank of such episodes. This approach has a strong affinity with some Action Research programmes.

Within the time-span of the thesis a first attempt has been made to identify the 'fractal' nature of learning at different levels within the three schools, it being argued that learning is central to the life of schools. Other Complexity principles have also been explored culminating in a proposed pair of 'attractor states' for schools in the study. These findings have been compared with those generated by official inspections and by school effectiveness and school improvement approaches. A principal outcome of the work has been a radical change in my own professional practice. This study makes a contribution to the understanding of the dynamics of learning and change within schools.

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Chapter 1 Introduction, Overview and Professional Context.

Introduction and Overview

As an Education Adviser working for a South Wales local education authority I have a professional interest in school improvement and in the body of research associated with school effectiveness and school improvement (SESI). Over a number of years I have begun to feel dissatisfied with large sections of this research. The reasons for this dissatisfaction revolve around the fact that much SESI research, when addressing issues of change, appears to rest upon assumptions of linearity and smooth transition. On the one hand, the identification of school effectiveness generally involves the utilization of classical statistical techniques which pin-point key factors for effectiveness. On the other hand school improvement projects often assume that methodical and systematic work utilizing rational planning will eventually realize a desired improvement goal. The problem I have with these approaches is that they do not reflect the dynamism of schools and do not appear to 'explain' the way schools change over time. In looking for alternative perspectives I have become interested in the possibility that Complexity Theory and the related Systems Theory might offer some ways of handling this dynamism. Complexity and Systems Theory have afforded useful insights in physical science and more recently in the business field. I believed that some educational contexts might also prove amenable to Complexity analysis.

The central concerns of this thesis are first, whether Complexity Theory can be applied to the study of education, and second, what the implications are, particularly for my practice, should there be justification for assuming a Complexity Perspective. The key methodological issues are how one might go about attempting to 'operationalise' Complexity in educational contexts and what might count as a Complexity effect? Associated with this is the question of what instruments might be used to detect Complexity. I am not the first person to link

education with Complexity Theory¹. To the best of my knowledge this work is the first attempt to relate Complexity Theory directly to practices in schools and therefore the first attempt to move from a philosophical to an empirical frame. I did not have in mind the development of a mathematical model based on Complexity Theory, but rather to use the physical context of Complexity Theory as an analogy in a similar way to that outlined in business literature.

I envisaged that this study would be of limited scope given the restraints of time and resources. Within these constraints I hoped to be able to explore some aspects of the school context where Complexity Theory would be most likely to be of relevance. I expected to utilise data already available and to generate some data myself. I realised that the techniques for generating and analysing such data might not be well developed and to this extent saw the project as involving an exploration of possible methodologies compatible with Complexity Theory. Such methodologies were likely to be generative and dialogical in the spirit of Complexity Theory and might be applicable to qualitative and/or quantitative data. In short, I did not expect to conclude the project with a set of watertight outcomes or with a well-developed theoretical framework. My aim was, if possible, to establish a first base along the route towards the utilisation of Complexity Theory in an educational setting.

For reasons which will be explained I decided to make 'learning' a key focus for my work, in particular learning at different levels and as an activity undertaken by people holding different positions within schools. Learning is arguably the core business of schools, it is also arguably a dynamic process. My own role involves support for learning, principally of teachers but also of pupils and in some sense whole schools. This work, therefore, goes straight to the heart of my own development as a reflective practitioner.

¹ See, for example Fullan [1999], [2003] and Morrison [2002]

The thesis follows a logical sequence. After describing the context of my professional practice in Chapter 1, Chapters 2 and 3 explain my concerns with Current SESI research and outline the possibilities contained within Complexity Theory. In Chapter 4, I present a critique of a selection of the writing on learning and change, followed in Chapter 5 by the development of the methodology for the thesis. In Chapter 6, I start with a description of the background and contextual features of the schools involved and summarise the use I made initially of the data collected in these schools. Some techniques, such as those utilizing learning Episodes, have potential for exploring Complexity Theory which will take time to develop beyond the scope of this thesis. The data collected while using Learning Episodes was, however, available for more immediate analysis using techniques in line with Complexity Theory. Chapters 7 and 8 describe the analysis and use of both quantitative and qualitative data which developed out of the initial work summarised in chapter 6. The juxtaposition of several data representations in electronic form which can then be interrogated in a non-linear way clearly links this work with modes of hypertext communication. The final Chapter 9 draws together the strands and provides a conclusion within which my main findings are stated and the implications for my present and future practice discussed.

At the start of this work my principal motive was to explore Complexity Theory as the provider of a complementary perspective to mainstream SESI research. In the event I hope to show in the conclusion that some original and valuable insights and techniques have been developed during this thesis and that the implications, particularly for my own practice, are far-reaching.

Professional Context

Context of the Local Education Authority (LEA) in which the work was undertaken

Torfaen County Borough Council is a unitary authority, established in 1996 and covering the towns of Blaenavon and Ponypool in a South-East Welsh valley and

extending to the new town of Cwmbran. There are 18,000 pupils within the Authority attending 40 primary, 8 secondary, 1 special and 3 nursery schools. The overall County Borough percentage of pupils entitled to free school meals is around 22%. The unemployment rate within Torfaen is lower than the Welsh average at around 4%, although the Basic Skills Agency has identified a significant number of adults in the Authority as having low levels of literacy and numeracy.

The Role of the LEA in England and Wales

The role of LEAs and LEA advisers has been undergoing change in England and in Wales during the past decade. The 1988 Education Reform Act introduced Local Management of Schools, Open Enrolment, the National Curriculum and opportunities for schools to opt out of LEA control and become grant maintained. The traditional functions of the LEA were reviewed in the DFEE [1997] consultation paper 'Excellence in Schools' and the corresponding 'Building Excellent Schools Together' from the Welsh Office [1997].

The new role adopted by the most effective LEAs is now that of a partnership between a proactive LEA and an empowered school. LEAs are obliged to monitor pupil progress and thus facilitate self-improvement by schools. Support must be targeted on schools most in need. The LEA is required also to act as a broker of good practice. In order to ensure that this programme is carried out LEAs are required to produce an Education Development Plan against which they are judged through a new system of LEA inspections. An effective LEA, according to the Audit Commission [1999] guidelines, will be one which intervenes effectively and appropriately to raise standards of pupil achievement. In order to do this LEAs must have a system for identifying 'more' and 'less' effective schools.

Different frameworks for LEA inspection have been produced in England and Wales with the Welsh inspections focusing initially on support for literacy and numeracy. The general principles defining the role for LEAs in the two countries are very similar. However, the approach to raising standards of numeracy is

distinctly different in the two countries. In England, a detailed framework for the teaching of numeracy has been devised along with training materials, money for numeracy consultants and a plan for implementation. In Wales, LEAs are given the responsibility of devising their own numeracy and literacy strategies.

The Welsh document 'Raising Standards of Numeracy in Primary Schools: A Framework for Action in Wales' [OHMCI, 1999] is of particular relevance to my work as an Education Adviser with responsibility for mathematics. It gives LEAs a central role in the process of writing and implementing numeracy strategies. Rather than prescribing the detail, the Welsh Office states that:

The development and Implementation of numeracy policies in Wales needs to be: Evidence based – drawing on the latest available information on the most successful approaches being pursued in Wales and further a field; Professionally informed – building on the significant achievements of teachers in Wales in this area to date; Locally supported – with well-targeted training and support for the work being done at school level. [OHMCI, 1999, p5]

Additional resources have been made available to Welsh LEAs through the Grants for Education Support and Training (GEST) fund to develop and implement numeracy and literacy strategies.

The Torfaen Advisory Team

In order to deliver the requirements in the above section, the advisory team has been growing steadily since 1997. For the past four years there have been advisers in post for English, mathematics, science, Welsh and special educational needs, two primary advisers and a principal adviser. More recently, advisory teachers for mathematics and English and an adviser for Information and Communication Technology have been appointed. Advisers link with a cluster of schools as part of their role apart from their specific subject responsibilities and

take a more strategic role, combining support for specific aspects with monitoring and review. Advisory teachers are specifically focussed on improving classroom practice in Key Stages 1 and 2. They are line-managed by subject advisers who negotiate their use with schools which appear to be most in need of support.

Defining The Adviser's Role in Torfaen

The role of advisers in Torfaen has been developed in response to the policy documents cited above. There are two parts to this role, that of School Development Adviser and of Subject Specific Adviser.

School Development Adviser (about 45% of time), which involves:

Working with a cluster of 8 schools (1 secondary):

Through consultation with the headteacher, staff and governors, the role of the School Development Adviser will be to:

- (i) Listen to concerns, challenge and influence thinking, seek out alternative solutions, provide a wider perspective from outside the school and promote change.
- (ii) Support the ongoing development of quality assurance systems which;
 - (a) develop, implement, review and refine self-review and evaluation process;
 - (b) assist in setting and monitoring realistic and achievable improvement targets.
- (iii) Support improvements focusing on the teaching and learning process and helping to raise standards of achievement.
- (iv) Build up a working knowledge of the school and its effectiveness.
- (v) Establish a clear early-warning function, which can then ensure differentiated levels of support for schools encountering difficulties.
- (vi) Foster a close working relationship between the LEA and schools.

As a Subject Adviser (about 55% of time)

- (i) Lead on the writing and implementation of a strategy for raising achievement in the subject within the Authority. Co-ordinate training, in-service and support for teachers from Early Years to Post- 16 within the Authority.
- (ii) Helping schools to review their subject provision, plan schemes of work and lessons.
- (iii) Helping schools to monitor and evaluate their work in the subject and track the progress of individual pupils.
- (iv) Some element of review for the Authority in cases where schools appear to be under-performing.
- (v) Keep in touch with sources of information and external agencies.
- (vi) Liaise with other LEA departments, parents and community groups, Higher Education Institutions.

The Advisory Teacher Role

Advisory teachers have been appointed in Torfaen for mathematics, English and special educational needs. Their role is specifically to work in schools to assist teachers develop their classroom practice. Advisory teachers spend much of their time in designated schools giving demonstration lessons, observing and giving feedback to teachers. The major focus of the work of advisers in Torfaen, as can be seen from the above description, is on school improvement. Advisers and advisory teachers combine to provide in-service courses both in school and centrally. These vary in length from a half day to longer courses of up to five days.

The Work of Advisers Prior to this Project

As will be seen in later chapters my mode of working is changing significantly in the light of the work done for this thesis. I will now give some of the detail of the work

of advisers building on the outline above in order to provide some measure of these changes. There are three sets of information upon which advisers make judgments about the effectiveness of schools in their patch and make decisions about appropriate models of support. These are: pupil performance data, external inspection reports, and personal observation and discussion. Pupil data comes in a range of forms, the principle one being the percentage of pupils achieving different levels or grades in National Assessments. This is often split by gender. There are no official league tables in Wales. There are, however, benchmark tables which group schools according to the number of pupils eligible for free school meals. A school's results can be checked against the median, upper and lower quartile scores for schools in the appropriate band. In Torfaen, a system of 'alerts' is also in operation. Schools receive a score against a range of indicators, such as, difference in mathematics achievement of this year's cohort against that of last year's, or difference in achievement of girls and boys. At present these results are all at school level although there is a move to include more pupil-level data and measures of progress over time. There are major difficulties with making judgments based on school-level data taken at one point in time. These difficulties include, comparisons of cohorts (especially in small schools) and of using free school meals as a proxy indicator. Advisers are more or less acquainted with these problems although the alerts are given a fair degree of credence.

Regular discussions about schools may start with an alerts list but also take into account the other two sources of data. Inspection reports are important documents in that they provide an official and external evaluation of the school which the school is obliged to act upon. More than this, however, the advisers are all trained inspectors and strongly influenced by the framework for inspection. For these two reasons the inspection framework is a powerful influence on the assessment of effectiveness and on decisions about support. Because of political pressure extensive support is given to schools to ensure that they meet the requirements of the inspection framework. Advisers also rely on a range of subjective and semi-objective data including judgments of the elusive 'ethos' of the school. In short the

full range of experience built up by working across educational establishments is utilized to make judgments about the effectiveness of teachers and schools. These impressions are discussed in regular team meetings and judgments reinforced by the sharing of views among advisory colleagues. Although vitally important there are some concerns with these judgments. First, they prioritize the structural elements of the school, the display, the documentation, the demeanor of the key managers and may make assumptions about pupil learning. Second, the basis of the judgments is not open to criticism since it is not recorded or articulated, apart from the minutes of advisory team meetings. The only commonly acknowledged framework is that of the ESTYN inspections which is not open to criticism or amendment. Part of my aim is to augment the present judgments with those focused on learning and to move towards a method of making these judgments available for reflection. It also seems fundamental that teachers and to some degree pupils should be involved in any judgments about effectiveness since any improvement must ultimately be engineered by them. This is made possible by the publishing of case records in a hypertext form which is planned as part of this project. Concerns with the current research on school effectiveness and school improvement are discussed in the next chapter.

Chapter 2 School Effectiveness and School Improvement Research: Comparisons with Complexity Theory.

This thesis explores how Complexity Theory can augment and complement work on School Effectiveness and School Improvement (SESI). In identifying areas where this may be appropriate it is important to investigate some of the strengths and weaknesses of SESI research as it stands. This chapter will summarise some of the main strands of SESI research and indicate the principal criticisms which have been levelled at them. It will also establish some of the similarities and differences between SESI and Complexity approaches. This chapter concentrates on the main strands of SESI research developed up until the year 2001. More recent SESI developments are discussed in chapter 9.

The history of School Effectiveness and School Improvement (SESI) research over the past 30 to 40 years is well documented in the recent books, (Sammons [1999], Mortimore [1998], Teddlie and Reynolds (eds), [2000]). Within the book edited by Teddlie and Reynolds, three major strands of research are identified. These are:

School Effects Research (SER) – studies of the scientific properties of school effects evolving from input-output studies to current research utilizing multilevel models;

Effective Schools Research (ESR) – research concerned with the processes of effective schooling, evolving from case studies of outlier schools through to contemporary studies merging qualitative and quantitative methods in the simultaneous study of classrooms and schools;

School Improvement Research (SIR) – examining the processes whereby schools can be changed, utilizing increasingly sophisticated ‘multiple lever’ models. [Teddlie and Reynolds (eds), [2000], page 3]

The above definitions cover a broad and varied range of research within and about

schools and I will utilize them when considering how Complexity Theory compares and contrasts with SESI research. As Teddlie et al and others (for example Gray et al (eds), [1996]) point out, there has been a call for the three strands above to be merged in future developments of SESI research. It is claimed that this would allow what practitioners believe to be the understanding of factors associated with 'effective schools' to be used to improve those which are less effective. It is acknowledged by many within SESI research that the processes involved are complex and that 'less effective' schools, for example, do not simply lack what 'more effective' schools have, (see Sammons et al [1995]). I hope to show in this chapter, however, that SESI research does not adopt a systematic approach to dealing with this complexity, and that it retains assumptions of linearity, without addressing the truly dynamic nature of many educational settings.

In this chapter I will also explore some of the strands of SESI literature in order to show the similarities with and differences from work in Complexity Theory. There have been a number of criticisms levelled at SER and ESR in particular. I will do no more than touch on these. I will argue, however, that all three strands above share a common set of assumptions which limits their usefulness to particular educational settings at particular times. In a later chapter I will provide a comparison of work carried out within a SESI paradigm with that from my Complexity Theory inspired perspective in order to demonstrate the value of the later. In studying the literature it is interesting to speculate that far from a merging of traditions, there could be a greater diversification of approaches now. This, in itself, is to be expected if one is sympathetic to a Complexity approach.

The development of SESI research has been characterized on the one hand by increasing sophistication of the use of statistical techniques, including multi-level modeling and longitudinal studies, and on the other hand by the collection of qualitative data to augment quantitative performance indicators. I will argue that both of these methodological approaches rest on assumptions of system linearity which, although valid for some states of the systems and some times, are not

always appropriate. It may be useful to consider a parallel with the development of Newtonian science in the understanding of the physical world. Such science is limited to the explanation of linear behavior. Newton's laws of motion satisfactorily describe a vast range of everyday events, however, the laws are of no use in explaining turbulent flow, for example. I will argue that there may be many occasions when positivist and/or reductionist approaches to the study of education communities reach a similar impasse. In the case of social phenomena turbulent behavior may be the norm.

The Assumptions Underlying SESI Research

Systems Thinking approaches² which have much in common with Complexity Theory have been developed within a business context and represent an attempt to overcome the perceived shortcomings of reductionist analysis. Richmond and Peterson, [1997] suggest that reductionist approaches to explaining phenomena (either physical or social), rest on three contestable assumptions.

Assumption 1: that an effect may be explained by a list of causes and that these causes may be prioritized according to magnitude of effect. The causality described is one-way.

Assumption 2: that causes are external to the particular phenomena or the system under scrutiny.

Assumption 3: that the causes are relatively independent of each other.

I suggest that these assumptions are explicit in the work of leading practitioners in the SESI tradition. For example, a recent international research project, (Reezigt ed. [2001]), drew on work done in eight countries over three years and attempted to identify and synthesize SER and SIR outcomes. The authors state that 'The first step will now be the selection of factors that are important for effective school improvement.' (p5). This implies that the three assumptions above are being made in this work. Interestingly, once the factors were finally 'identified' and presented in

² Stacey et. al. [2000] argue that a central assumption of systems thinking is that systems have a strong tendency to move towards a state of order and stability, dynamic assumptions are shared with Complexity.

a diagram, the authors remained dissatisfied with the result. They believed that the resultant model was too static and proceeded to construct a flow diagram which attempted to show interactions of some of the main features of the school system. This suggests that the authors realized the limitations of the factor approach that they used initially.

A comparison between factor and dynamic approaches is illustrated by Richmond and Peterson, [1997]. In this case a common approach to the identification of 'factors associated with student achievement' is compared with a Systems Thinking Model in which key features are seen to be in dynamic interplay with student achievement. In the first representation, respondents identified a list of factors (many of them external) thought to be associated with higher achievement. In the second a selected set of interlinked features are shown demonstrating how they might influence one-another explaining a large part of their interdependence and highlighting the importance of internal factors.

The two representations below are suggested in response to the question: 'What are the influences on student academic achievement?' (source: Richmond et. al. [1997])

DIAGRAM REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER
LEGAL ISSUES



2) Systems Thinking Model

DIAGRAM REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES



Fig 2.1 A Comparison of Linear and Dynamic Explanatory Models (Barry Richmond [1997])

Representation 1 above suggests independent factors involved in a one-way causal connection with student achievement. Although the factors in representation 1 above are important, Complexity Theory proponents claim that an understanding of the system is not gained by singling these out, but rather by investigating the interplay of key elements as depicted in representation 2. As well as depicting the dynamic interplay of factors, representation 2 allows for navigation in a dynamic fashion which is characteristic of a hypertext environment.³ Numerous criticisms

³ Turkle [1997, p17] describes this as allowing the reader to create her own links between related texts, videos and photos as well as being able to travel along the links made by others.

have been leveled at School Effects Research (SER) and Effective Schools Research (ESR). These are discussed now in more detail.

Criticisms of School Effects Research and Effective Schools Research

SER and ESR research programmes have attracted their fair share of criticism. There are lively debates recorded in White and Barber eds. [1997] and more recently in the pages of the international journal, School Effectiveness and School Improvement [vol 12, # 1, March 2001]. These concerns can be summarised as follows:

- That the methodology is flawed or limited.

And the two related criticisms:

- That the influence schools can have on pupil attainment has been overstated.
- That the status of SER and ESR research rest more with their political usefulness than with their ability to provide important insights into school systems.

Criticisms of Flawed Methodology in SER and ESR

Many of the criticisms about methodology come from the SER and ESR researchers themselves. Goldstein [1997] notes that studies which attempt to identify more effective schools often have limited validity and do not identify significant factors for several reasons:

- The prior attainment of pupils is not taken into account and this is a major factor in pupil attainment at a later stage.
- Schools are differentially effective in different subjects and with pupils of

different ability, which is not reflected in a single figure.

- The statistical uncertainty of data is large making it very difficult to distinguish the so-called differential effectiveness of schools.
- Schools change over time, however, the attainment data used reflects only one cohort and is essentially historical data.
- Student mobility between schools is not reflected in the tables.
- Social factors, sex of students, ethnic origin and social background are not taken into account. These factors are out of the school's control.

Measures to overcome these problems include multilevel analysis, which reflects the hierarchical nature of the data and longitudinal studies which involve measures of individual attainment at different times. Such measurements, claims Professor Goldstein, allow pupil progress to be ascertained and therefore provide a fairer comparison of school effectiveness. However he points out that statistical uncertainty is still too large to allow fine discrimination between institutions, 'only extreme schools can be separated from the average' [Goldstein et al [2000], p 25]. The conclusion that Goldstein reaches is that longitudinal, multilevel measures, possibly the most sophisticated statistical measures of pupil progress available, are useful within schools as one tool for measuring effectiveness. Such techniques, however, do not support the rank order of schools as presented in league tables and present no definitive or stable picture of relative school effectiveness.

More wide-ranging concerns about the SER have been expressed by others, for example, Peter Hill [1998]. He suggests that SER researchers may not always ask the right questions, that their work is often too narrowly focused on academic performance and that it does not reflect the dynamics and growth of school environments. This concern about the narrowness of focus is reiterated by Jamieson and Wikely [2000], who point out that schools should emphasise diversity over uniformity and that it is the way schools cater for diversity that is important rather than their conformity. An extension of this argument suggests that

we should be identifying (and celebrating) difference and finding ways of broadening the range of techniques available for analysing school effectiveness.

The notion that all schools can achieve high levels of pupil performance is also challenged. By tracking pupil progress over time, it can be shown that in some schools pupils make more progress than pupils starting from the same level of attainment in other schools. An approach which attempts to isolate independent factors might suggest that all schools could adopt the practices of the 'most effective'. Sharon Gewirtz [1998] argues that for one school to become 'effective', others around it may need to reduce their effectiveness. This view is reminiscent of the idea of a 'fitness landscape' which is prevalent in Complexity Theory and which will be discussed in later sections. The Gewirtz argument suggests that limitations in SER and ESR are more than simply methodological and that they are inherent in assumptions about linearity and stability within schools and across schools.

Criticisms of SER and ESR from a Political Perspective.

It is acknowledged that the academic outcomes achieved by pupils have more to do with the social background they come from than the school that they attend, (see Mortimore, [1998] page 70 for a discussion of this). Martin Thrupp [1999] argues that the difference schools make is overstated and that governments find it easier to blame teachers and schools rather than change underlying social conditions. In reply, it is claimed that, although small, the 'school effect' is nevertheless highly significant since it can radically alter life chances. For example, the difference to future training options for pupils obtaining grade Ds rather than Cs at GCSE is marked.

Morley and Rassool [1999] expand upon the point made by Thrupp. They claim that the School Effectiveness agenda is an example of 'new managerialism' at work in education. This is fuelled by the desire of national government to control schools from the centre. They see SER as generally positivist, evangelical, socially

decontextualised, technicist and narrow. The 'problem' of ineffective schools is sensationalised, according to Morley and Rassool. SER then provides part of the solution to this problem in the minds of some Government officials. The Department for Education is clearly wedded to an agenda of 'raising standards'. Roger Slee et al eds.[1998] summarise the main thrust of these criticisms with the title of their book, 'School Effectiveness for Whom?', which suggests that ratcheting up test scores may be more about political expediency than increasing pupils' conceptual understanding or ability to apply their knowledge.

Stephen Ball [1990] criticises SER and ESR for excluding the dimensions of human interrelationships and the distribution of power within schools. He provides an analysis of a sample of schools from this perspective and as such serves to demonstrate the complexity of school communities. Authors such as Ball and others, acknowledge the difficulty of 'capturing' the complexity of schools and the interactions within them. Sammons, et al, [1995] in 'The Key Characteristics of Effective Schools' attempt to identify the 'correlates of school effectiveness'. This report concludes a wide-ranging review of school effectiveness literature designed to distill out the 'key determinants' of school effectiveness in secondary and primary schools. The authors themselves point to the tentative nature of these key characteristics. They point out that correlation does not establish causality and that transferability of results from one set of schools to another is problematic. These key determining features are not to be seen as a blueprint for success in the educational field but rather as areas to be considered by schools in the process of self-evaluation.

The work reviewed by Sammons et al, [1995] appears to make the three assumptions described above by Richmond and Peterson, [1997]. Clearly many of the characteristics influence each other (for example purposeful teaching and monitoring progress). While there is no suggestion from the authors that schools can or do simply pick the characteristics that they want from the list of eleven, the question arises about what it means to express these characteristics in a list. It is

just as plausible that all effective schools have subsets of the eleven characteristics. Having sets of the characteristics together, however, may be an entirely different matter. Sammons, et al, [1997] point out that departments within secondary schools are differentially effective and that effectiveness of such departments varies over time. In fact, Sammons et. al. [1995] are at pains to point out that 'failing schools' are not simply the antithesis of effective schools but may have quite different dynamics. This appears to contradict the assumption of linearity contained in much of the work they review.

An example of the shortcomings of treating factors as independent within educational research is provided by Riley et. al. [1999, p8], who used factor analysis in this way to identify effective LEAs. In her statistical work, Riley identified five key features. When taken individually these five predicted about 35% of variation between LEAs. Taken in combination, however, they predicted well over a half. To what extent can these factors then be thought of as separate? A second example, in another context, involves the recent claim by researchers into nutrition and cancer that some foods eaten together may be '13 times more powerful in attacking cancer together than they are when eaten alone.' [Radio 4, 31\03\2003]. If this finding is substantiated it illustrates the fact that elements in combination can have a radically different effect from the individual elements.

Alternatives to the factor model, The School Improvement Paradigm

The best information that can be expected from large-scale quantitative work is a set of correlations between performance indicators and factors which appear to make a difference. Even if these correlates illustrate points of statistical significance, they do not provide causal explanations. Complexity Theory uses large-scale observation and data collection to identify patterns of events but avoids attributing the occurrence of these to independent factors. Complexity Theory also attempts to balance the importance of detail and variation at each level with a more holistic picture. Classical Statistical techniques tend to smooth out interesting and

highly important detail in data. In later sections I hope to show how this detail can be explored to provide useful information. The school improvement paradigm is generally thought to operate more at the level of causes, investigating methods by which schools can increase their effectiveness. There are a wide range of initiatives which come under the heading of 'school improvement'. From unashamedly top-down programs such as the National Numeracy and Literacy Strategies in England to action research projects designed and conducted by teachers. Because of the diversity of school improvement programs, each has to be considered on its own merits. It is possible, however, to make some general points.

Those initiatives which are oriented towards a top-down approach are usually based on three assumptions. First, that lessons learnt elsewhere can be transferred to other schools and contexts. Second, that with perhaps only minor adjustments, one solution can be found to an improvement problem. Third, that external agencies can, and are perhaps best placed, to provide the motivation and tools for improvement. Serious concerns can be raised about all three of the above assumptions. The rather poor track record of top-down innovation perhaps speaks for itself. With regard to the third assumption, the issue of side-lining teacher professionalism is a major concern. To use Louise Stoll's [1999] phrase, unless the 'internal capacity' of the school, (defined as 'the power to engage in and sustain continuous learning of teachers') is developed there is little likelihood of deep and sustained improvement.

An example of the tensions inherent in top-down improvement programmes can be seen within literacy and numeracy in Britain. The National Numeracy and Literacy Strategies in England are blatant attempts at raising standards from the centre. In the terms of reference established by the projects themselves, there are indications of success. Preliminary reports suggest that test scores have been improved significantly in England. A second indicator of success could be considered as the enthusiastic uptake of the framework for these subjects (at least for numeracy) in

Wales, where it is not compulsory. This may indicate that many teachers do appreciate prescription. This prescription, however, may result in a short-term boost to test scores without any lasting and continuous development in pupil understanding. Indeed there is a danger, with this centralised approach, of developing dependency rather than independence. The projects are being evaluated by a Canadian team. Professor Fullan who leads the evaluation team, suggested recently (Fullan, [2001]), that prescription may be useful in the initial stages of large-scale innovation, but that the development of internal capacity is essential for sustained improvement.

At the other end of the school improvement spectrum lies a rich tradition of teacher action research. This is encapsulated in the 'internal capacity' definition quoted above. Within this approach, the teacher and pupils are placed at centre stage. The teacher is seen as being best placed to identify the need for improvement and how to implement this in the local context. Many action research projects escape the criticisms levelled at top-down projects. Jean McNiff [1997] typifies this approach. The prime-mover in such school improvement projects is the reflective practitioner who decides on her or his own agenda for research and improvement, possibly in collaboration with colleagues. In practice, however, such self-direction is rare. Rarely do school managers give control over to teaching staff. The pressure for accountability coupled with an underlying belief that improvement is best planned outside the classroom ensures that such teacher action research remains the preserve of the few. This may be due in part to an adherence by most practitioners to a view of linear causality as expressed by the factor model.

There is awareness within the School Improvement traditions that reductionist approaches have limitations. School Improvement Research (SIR) and the accompanying improvement programmes vary widely in their underlying assumptions. Some are clearly reductionist and others take more account of the dynamic nature of the system. These later approaches contain important references to feedback and the interrelationships between elements. Metaphors

have been used for change and improvement in schools which reflect this emphasis on dynamism and share some similarities with Complexity Theory. For example, MacBeath et.al. [2000] refer to the 'cat's cradle' affect whereby movement in one area of schooling has a profound affect on all others. School Improvement programmes such as those led by MacBeath, utilize some of the concepts and language found within Complexity Theory but do not embrace it fully, as I will show later when contrasting them with a Complexity Theory approach.

Few researchers attempting to measure school effectiveness rely entirely on large-scale quantitative studies referred to above. Increasingly common is mixed-methodology work such as the Improving School Effectiveness Project (see MacBeath and Mortimore (eds) [2001]) and work which emphasises the importance of self-review by schools themselves (such as MacBeath [1999]). This can be seen as the culmination of work and refinement of methods in the field stretching back to work in London schools in the late 70's (Rutter et al [1987]). Such research projects are often described as a mix of School Effectiveness and the School Improvement tradition. A further example of this development is the 'Improving the Quality of Education for All' (IQEA) project and the move by one of its principal authors to establish 'Authentic School Improvement', Hopkins [2001].

Some who are uncomfortable with 'quantitative' approaches argue that social events can only be understood in terms of the meanings for the actors themselves. This essentially precludes generalization since each locality has its own context and meaning is context-specific. It seems to me that a major problem for this approach is that it contains an inherent contradiction. For any set of events to have meaning to those outside of the locality (presumably those reading accounts from the outside are expected to find them meaningful), there must be some overarching commonality. The situation is often presented as quantitative versus qualitative. Either accept a reductionist approach where statistical analysis extracts simple law-like regularities or accept an in-situ description which remains subjective and local. Attempts to integrate the two by arguing perhaps that

statistical techniques are appropriate at a macro level and case-studies for a micro understanding do not really escape the criticisms of either.

I hope to show that Complexity Theory overcomes some of the shortcomings in SESI research by providing insights into the way events within a dynamic milieu can cluster to form identifiable patterns, and how such patterns develop through feedback from diverse starting points. In preparation for this, the main features of Complexity Theory will be introduced in the next chapter.

Chapter 3 Complexity Theory

Introduction - Why should Educationalists be interested in Complexity Theory?

I argued in the last chapter that most SESI research and projects are underpinned by assumptions of linearity inherent in reductionism. These assumptions have served the physical sciences well but may not always be appropriate for the study of schools. In this chapter I summarise the main features of Complexity Theory and discuss the application of these to physical and social contexts. I spend some time describing the key features of Complexity Theory which I have utilized in my work since there are a number of developing strands in the literature which take quite diverse view points. An important preliminary activity, therefore, was to articulate a clear vision of Complexity Theory as it would be applied in the thesis.

Classical western science promotes a rational, deterministic view of the world within which constituent parts can be studied separately, and in which the parts can be viewed as acting independently. Given the set of assumptions upon which classical science is based, it makes sense to pursue understanding of a system by systematically controlling the presence or absence of constituent parts. Reductionist approaches and classical statistical methods are logical extensions of this thinking. This has been a successful approach when applied to closed, physical systems. In particular, within the discipline of thermodynamics, order and control are dependent upon the deliberate expenditure of energy to counteract the 'inevitable' and 'irrepressible' progress towards the death of the universe. There are many intuitive examples of this behaviour, for example, the fact that objects spontaneously cool down or warm up to an average room temperature, the fact that a single pendulum comes to rest at its mid-point and that its motion can be mapped and predicted accurately at any point after its release from a non-central position.

Not all physical systems can be modelled in the way that a single pendulum or a heat-radiating body can. Smoke from a burning object in a still room, for example, starts rising in a linear and predictable way but soon attains a turbulent state. In fact many systems will change from a linear to a non-linear state as some of their parameters change. In the case of the smoke in the example above the velocity changes as the smoke rises in hot air. An interesting discovery made during the last fifty years is that within systems in a turbulent state, pockets of order spontaneously arise. Such systems are prone to flip in and out of a state of order.

Complexity Theory is essentially a set of ideas and a language which helps to describe and categorise the observations discussed above. Originally this theoretical frame was applied to physical systems (see for example Prigogine [1996]). Increasingly, such ideas are being measured against biological systems and are now quite commonplace in the context of business organization and economics. For example, Wheatley [1999] suggests that we view organizations as being more like living organisms than machines. As such, we need to modify traditional views on controlling organizations. Wheatley argues that organizations are dynamic, non-linear networks of relationships and cannot be separated into parts while maintaining their essential identity. This view is one of the key features of Complexity Theory, which will be described more fully in the following sections.

A Summary of the Key Elements in Complexity Theory

Systems which lend themselves to a complexity analysis:

- are **dynamic**, that is they are continuously changing
- are **far from equilibrium**, have the potential to change suddenly and may take one of two paths, (**bifurcate**).
- are **open systems**, that is interchange energy (and information) with their surroundings

- involve **feedback**. What happens next depends on what happened previously.
- are systems where the **whole is more than the sum of the parts**
- are **causal** and yet **indeterminate**

In such systems:

- patterns **emerge** which cannot be predicted by looking at the parts of the system. These can be in the form of **attractors**, a small number of patterns to which the system gravitates from many starting points. The surface complexity is the result of underlying simplicity.
- **Autopoiesis** may be a feature, that is the system may change its form or behaviour in order to maintain its identity in the face of changing conditions.
- **Complex Adaptation** is likely to be a feature, that is the system will be '.....composed of a diversity of agents that interact with each other, mutually affect each other, and in so doing generate novel, emergent behaviour for the system as a whole. The system is constantly adapting to the conditions around it and over time it evolves.' (Lewin [1999], p198). Competition and 'survival of the fittest' is one aspect, another is the spontaneous emergence of order. The parts of such a system '**co-evolve**' and move spontaneously towards the **edge of chaos** where the ability to utilize information is greatest. Systems in this state are able to resist invasion since the parts support each other. However, the down-side is that a change in one part may have serious implications for the whole system.
- Changes are **irreversible**, since the interaction of parts together is transforming.

The key ideas of Complexity Theory will now be expanded by considering specific examples in physical and social systems.

Systems which involve causal relationships but are not deterministic.

Non-linear systems are deterministic in the sense that causes and motives prevail. They are not, however, determined. The sensitivity and criticality of initial conditions and the fact that the resultant information at one moment then feeds back to influence and change the next state means that the system is not fully predictable. An example of this is the magnetic pendulum⁴. The motion of this object is not random, however, it cannot be defined mathematically. The resultant behaviour exhibits patterns referred to as the 'strange attractors' of the system. (Attractor, because behavior appears to be bound within a set of states and strange because the system may jump between these states after being given the smallest of nudges.) Strange attractors are made visible when a 'phase diagram' is constructed of all the possible states that a system could take. For complex systems, the actual states that the system takes will form a pattern on the phase diagram. These attractor states can be arrived at from many different starting points and have relative stability. The rings of Saturn form visible attractors. They are made up of asteroids, which can maintain only distinct distances from the planet due to the gravitational attraction from other parts of the solar system. The rings form visible strange attractors. Another related metaphor used for describing the state of a system over time is that of the Fitness Landscapes (The use of these in education is discussed at length in Morrison [2002]). This is the possible states a system can take somewhat like a mountain range, with its peaks and troughs. What is different from a mountain range, however, is that the peaks and troughs are not static. For example, a school attaining a particular state may affect the landscape for other schools in the system. As Gewirtz [1998] points out, a school doing well in a neighbourhood may attract the highest achieving pupils and the best staff, thereby suppressing scores in other schools close by. Another feature of the metaphor which matches observation is that a school may need to go down the slope in order to rise to a higher peak. This has possible parallels with the implementation dip which is often observed at the beginning of an innovation.

⁴ A magnet suspended by a thread above a second magnet, with like poles facing.

A further example of changing states can be observed when heat is increased underneath a shallow pan of oily liquid. When this is done the liquid at first conducts the heat without moving, then it begins to move with a rolling motion. Increase the heat still more and the erratic movement of liquid gives way to a layer of hexagonal convection cells with hot liquid rising up the sides and cold down the middle of the cells. Further heating leads to more erratic behavior. Some physical systems when driven by increasing heat, water flow or other variables, exhibit bifurcation. The system develops consistently for a while and then suddenly splits in two to take either a higher or lower value. Each of these arms then proceeds regularly but then bifurcation occurs again in each of the arms. An empirical observation is that the time to successive bifurcations becomes increasingly shorter by a constant factor.

Open Systems

The study of complexity is essentially about the study of open systems, which behave in particular ways. Open systems are those which interact with their surroundings and in which there is likely to be an interchange of energy, for example the magnetic pendulum described above. Examples of open systems include a heating liquid, a magnetic pendulum and the solar system. The behaviour of these systems are non-linear and involve positive feedback, that is, instead of damping or negative feedback, reinforcement can occur. An arresting example of such positive feedback occurs when a microphone is placed near a speaker in a public address system. In this example the feedback leads to wildly uncontrolled noise.

The ideas and language of complexity have been used in a range of contexts from weather systems, earthquakes, population studies to the behaviour of the stock market. A system becomes interesting in terms of Complexity Theory when it is far from its equilibrium point, in the region between rigidity and randomness, for example, at phase transition points, such as the melting point of a liquid. Classical

economics works on the assumption of diminishing returns. As such it is similar to the simple pendulum. There are times, however when positive feedback applies in economics. Brian Arthur [1990] uses the example of economic 'lock-ins', for example when a particular technological solution gains a slight advantage this can rapidly lead to an overwhelming lead since purchasers do not want to buy a product which will not be supported in the future. The QWERTY keyboard is often given as an example of this. Although not the best arrangement of keys this format has prevailed because of the cost associated with change.

Order from chaos

Implied within the complexity paradigm is the idea that the tendency to attain and maintain a state of order is as strong as the tendency towards disorder as depicted by the second law of thermodynamics. This tendency is summarized by the title of a book by Cohen and Stewart [1994], 'The Collapse of Chaos'. This maintenance of order can be observed in some sets of test results. Gomm and Hammersley [2001] studied health visitor examination results in one college over nine years. The cohort sizes were small. They found that the profile of results was remarkably consistent over the nine years. This was surprising given that one would expect a far greater variation in ability within these cohorts. They concluded that there were strong expectations from year to year that roughly the same number of students would achieve at each level. Gomm and Hammersley see this as an example of a human tendency to simplify by classification and to the pressure to conform. Human agency which is active in the case cited above is not a factor in physical settings, however the idea of a strange attractor may prove useful in examples involving social systems.

The discovery of order within systems in a chaotic state has led some people to speculate that matching the spontaneous tendency to disorder and entropy is an equally compelling tendency to order and that this occurs in open, dynamic systems when they are far from equilibrium. It is argued by some that such a

tendency is a prerequisite for the emergence of and maintenance of life⁵. The above discussion may sound like science fiction, but perhaps the important issue is whether or not there is any empirical evidence for such claims. What constitutes empirical evidence may itself be contentious. There are a number of examples of the spontaneous emergence of order and pattern within physical systems. Some chemical reactions, for example, sustain oscillation between two distinct states without any addition of energy. In the last fifty years, computers have facilitated the exploration of pattern generated by the repeated application of simple algorithms. Such patterns are staggeringly complex and beautiful and provide a visual example of the spontaneous emergence of order.

Hierarchy in systems

Underlying Complexity Theory is the notion that systems are hierarchical and that higher levels may be more than the sum their lower level constituents. In the non-linear systems which interest complexity theorists, the parts interact in a way which cannot be reversed. Light waves, for example, are linear. When light of different amplitude or frequency merge a complicated additive product is formed. These original waves can, however, be separated again. In a non-linear system, no separation is possible since the parts change each other and create a new state. In non-linear systems the 'arrow of time' runs one way. The implications for this are numerous. First, that a reductionist approach will often not be appropriate and that explanation of a lower order phenomenon may be by reference to the higher level. Furthermore, the higher level activity and organisation may 'emerge' from the lower constituents and may not be predictable by looking at the constituents. Contrary to reductionism, therefore, a Complexity approach may involve identifying patterns at a macro level which change and develop within defined limits.

⁵ This is discussed at length in Kauffman, [1995], Lewin, [1999], Waldrop,[1992], among others.

System evolution

Complex systems at the edge of chaos are inherently evolutionary. In such systems, order emerges out of chaos and stability is punctuated by rapid change. The ideas of Complexity Theory appear to be well established in the physical sciences. A key question to be addressed by this thesis is whether or not these ideas have any relevance in the study of education communities. I have been attempting to show that even seemingly structured activities can be analysed usefully using Complexity Theory. The game of chess, for example, involves around ten simple rules and is confined to the physical space of the chess board. Chess is a Complex, adaptive system. It is not appropriate to use classical statistics when studying effective strategies in the game. It makes little sense to think of determining all possible outcomes since these are huge in number and opponents react to each other's moves rather than following a 'rational' course. Game strategies and macro-rules have emerged over hundreds of years and still the game has potential for innovation and creativity. There is no attempt made by experts to reduce strategies at one level to the game rules at another.

Lewin [1999] points out that Complexity is more than natural selection and invokes the Social Darwinism of Herbert Spencer. The pure Spencerian view of the world, according to Lewin, is that increased complexity is an inevitable manifestation of the system and is driven by the internal dynamics of complex systems. Spencer quoted by Lewin [1999] describes this as 'heterogeneity from homogeneity, order out of chaos'. The pure Darwinian view is that complexity is built solely by natural selection. A blind, non-directional force; and there is no inevitable rise in complexity. The new science of Complexity combines elements of both: internal and external forces apply, and increased complexity is to be expected as a fundamental property of complex dynamical systems. In Complex Adaptive Systems this is manifested by the counterintuitive crystallization of order, ('order for free', in Kauffman's terms) upon which selection may act. Such systems may, through selection, bring themselves to the edge of chaos through a constant

process of coevolution, a constant adaptation. Part of the 'lure' of the edge of chaos is an optimization of computational ability, whether the system is a cellular automaton or a biological species evolving with others as part of a complex ecological community. 'At the edge of chaos, bigger brains are built', as described by Lewin [1999].

Complex Adaptation and Systems at the edge of chaos

Complexity theorists are interested particularly in systems, which operate on the 'edge of chaos'. These are characterised by a fluid structure, which is sensitive to changes. Such edge-of-chaos systems are referred to as 'Complex Adaptive Systems' (CAS), or as exhibiting 'self-organized criticality'. The words 'adaptive' and 'self-organizing' highlight the fact that organizing rules, which govern the behavior of these systems, are local rather than imposed from outside, often simple, and that they can readily adapt to change. Another way to characterize this adaptability is to say that information flows readily throughout these systems. A computer simulation of a flock of birds exhibits an example of complex adaptive behaviour, as described in Waldrop [1992]. Craig Reynolds quoted in Waldrop [1992] called the individuals in his computerized flock 'boids'. Each boid was programmed with three simple and local rules:

each boid flew at the same velocity as those around it (as far as possible)
each boid tended to move towards the centre of gravity of the flock.
Each boid kept as close as possible to other boids.

The resulting behaviour of this flock on screen proved to be remarkably similar to the real thing. Boids turn together and flow round objects in a similar way to flocks of real birds. There are two further important issues, which need to be highlighted here. First, that the behaviour of the flock can not be predicted from the initial rules. The flock behaviour can be said to be 'emergent'. Secondly, that it is typical of complexity approaches that computer simulations are often used to demonstrate or

explain this emergent behaviour. In the case of real birds the three rules make good survival sense, particularly if predators are near-by. Although the connections between the computer model and the real behaviour are circumstantial, the computer demonstration provides a model for thinking about bird behaviour. A second example of this type is of an ants' nest, given by Hofstadter [1985]. Individual ants operate according to simple, local rules, much like the boids. The resultant behaviour of the ant colony gives the impression of an over-arching 'intelligence' which emerges from the activity of individual ants. The colony can fulfill its needs and respond to emergencies. It is complex, since individual ant movements cannot be predicted, adaptive, reacting to the wider environment, and relatively robust, given that it will persevere even under extreme conditions. It is because of the complex adaptive nature of colonies that ants are a highly successful species.

The idea of a Complex Adaptive Systems (CAS), is a key element in Complexity Theory.

According to Lewin these are characterised by the following simple rules:

- 1) The source of emergence is the interaction among agents.
- 2) Small changes can lead to large effects.
- 3) Emergent patterns cannot be predicted.
- 4) A greater diversity of agents leads to richer emergent patterns.

[Lewin, 1999, p 202]

Lewin points out that Complex Adaptive Systems cannot be understood by mapping the detail of their structure because the 'way they work' is an emergent property. Individual parts do not have knowledge of the whole. In fact Holland in Lewin [1999] p220 points out that CAS emergent patterns persist even when component parts change. Factor analysis is therefore of limited value. CAS develop through a process of 'bricolage, a cobbling together of what is available, a

tinkering with the resultant assembly, modification on the basis of internal and external pressures and feedback. According to Lewin, CAS develop and refine information processing abilities. These arise as a 'natural' result of internal and external pressures. This could be seen in part as a result of natural selection and in part as an emergent property. Such emergent patterns are often restricted to a small number. For example, the eye is an attractor in morphogenetic space (Lewin, [1999], p40), which has evolved independently perhaps 40 times as a solution to the evolutionary problem of sensing electromagnetic waves.

If schools are Complex Adaptive Systems then factor analysis may be of limited use in understanding them. The limitations of factor analysis are experienced elsewhere. For example, scientists have complete DNA maps but have limited knowledge of how an organism assembles itself during development. This may be consistent with the fact that relatively few human genes have been identified given the variation and complexity of the species. Rather than determining human characteristics and behaviour as some people may expect, genes may act as generators of emergent patterns. Similarly, the social architecture of schools is certainly not irrelevant but may need to be supplemented by study at the level of the whole organisation.

The type of instruments and data-collection devices designed to collect information at this level are obviously critical. They have to be sensitive to the appropriate form of information. A key methodological question is how to operationalise complexity. I chose the collection of Learning Episodes (LE), as one approach, described in a later chapter, because it focuses on learning (which is central to the activity of schools and to the interests of teachers). By collecting LEs and working on them with teachers I hoped to generate information and processes which undergo complex adaptation. The strategy would then be to track the development of these. If Complexity Theory provides a useful set of descriptors for some educational contexts then it may be more appropriate to work within these as a bricoleur rather than as an engineer, to use a distinction drawn by Levi-Strauss [1966], where a

bricoleur is someone who solves problems practically with the materials to hand rather than planning in a more detailed way from a theoretical perspective.⁶

System behaviour over time

The notion of emergent order appears to have short and long-term implications. In some Complexity-inspired computer simulations there is an immediate ordering in the short term of elements to a small number of 'attractor' states when system parameters are tuned to specific values. Over the long term, systems in a critical state disintegrate according to a power law. It is suggested by Kauffman [1995] and others that the emergence and extinction of species over time may owe as much to this intrinsic activity as to asteroid collisions and the like.

The booms and busts of world economies and the occurrence of earthquakes have both attracted much interest from complexity theorists. Like earthquakes, incidents in the economy can be mapped over time. Interestingly there appear to be similar patterns emerging. If the size of earthquakes and of economic change is quantified, then in both cases a ten-times bigger event happens ten-times less often. This is not to say that the actual timing of an event can be predicted. In fact there is nothing to stop large catastrophes happening one after the other, and it may only take a small event to initiate a large catastrophe. As Buchanan [2000] emphasizes, over time the frequency of large and small incidents follows this 'power law' in a variety of contexts. Given the limited time-scale of this thesis it will not be possible to investigate such long term effects, however this might be a topic for future study. Not all systems are non-linear and therefore not all amenable to a complexity approach. Within our solar system, for example, the sun contains more than 99% of the mass. The movement of planets around the sun is not chaotic for this very reason. The gravitational pull of the sun overwhelms any interplanetary attraction, damping down chaotic motion.

⁶ Note the interesting similarities (and differences) between the use of the terms, 'Bricolage', Levi-Strauss [1966], 'p-prims', diSessa [1988] and 'design mode', Bereiter [2002b]. These all contain elements of

Criticisms of Complexity

The July/August (1994) edition of *Futures* magazine, Sardar and Ravetz eds [1994], was entitled "Complexity: Fad or Future?" There is concern expressed by some writers that 'complexity and chaos' refers to a collection of ideas backed up by a few interesting looking computer graphics but with no real independent basis. There is a real danger that the lure of computer graphics will convince some researchers to find chaos where it is inappropriate, and introduce notions of complexity where a more traditional explanation might be appropriate. There is much work to be done to establish the use of these ideas in the social sciences. Many arguments for complexity rest on analogy and simulation. The rigor of such approaches is debatable. The solution to this problem is that conclusions drawn will have to be tempered with extreme caution until (if indeed this is technically possible) a framework for the validity and reliability of work in complexity is mapped out. How, for example, does the boids computer program, or the study of ants nests relate to or assist our understanding of groups of humans?

There are debates about the ontological and epistemological assumptions underlying Complexity Theory. The notion of underlying mechanisms being of particular concern. Some important questions are: When do linear and when non-linear assumptions prevail? Are these assumptions the same in physical and in social science or are we simply being sucked into a set of mathematical diversions? What more do we understand about some phenomena from a complexity standpoint? These questions cannot be fully explored in this thesis. They are, however, important considerations and my aim, as a contribution to the debate, is to identify some methodologies and issues within education where Complexity Theory may be most relevant. In the remaining part of this chapter I suggest some areas within education where Complexity Theory may be applicable. These considerations provided the starting point for me when considering how to

Complex Adaptation. Such Complex Adaptation may be facilitated by publishing data in hypertext, where links can be formed and tracked between elements in a non-linear way.

design data collection instruments to investigate Complexity Theory.

Formative Assessment Feedback and Learning.

Black and Wiliam [1998] argue convincingly that formative assessment, defined as assessment where evidence is used to adapt the teaching materials and methods used, is crucial to successful learning. They argue this having scrutinized several hundred studies of pupils learning in different contexts. The theme of learning and feedback is not only apparent at individual pupil level. Reference to the need to focus on the diagnosis and the detail of learning is found throughout education literature; for example in the notion of the Reflective Practitioner (Schon, [1983]), The Intelligent School (MacGilchrist et. al. [1997]) and in literature concerned with the Learning Society. In fact if there is one central image which captures the essence of modern education it is that of the learning cycle. Learning clearly fits the definition of an emergent phenomena as explained by Holland [1998]. He claims that, in the process of learning:

- 1) There are underlying mechanisms generating enhanced understanding.
- 2) The whole is more than the sum of its parts.
- 3) Persistent patterns emerge.
- 4) The function of these patterns changes with context.
- 5) Higher level patterns can be built on lower level ones.

It may not be necessary to posit an 'underlying mechanism' as Holland does in point 1. The other four describe complexity without this recourse to realism⁷. The above points will be amplified with a few examples. Traditional models of learning where the mind was thought to be an empty vessel to be filled with information espoused a linear approach. Any form of developmental or constructivist view of learning implies a dynamic process. Denvir and Brown [1986] analysed the skills

⁷ Recently Skidmore [2003] has independently described the assessment and qualifications system as exhibiting features of Complex Adaptation.

and concepts associated with understanding a particular area of basic numeracy by low attaining 7 – 9 year olds. They constructed a network to show the relationships between these concepts and designed a set of teaching activities to address the concepts individually. Pupils were tested before and after elements of the teaching programme were delivered. Unsurprisingly they found that some pupils did not understand the particular concepts that were taught. What was interesting, however, was that some of the related concepts not taught directly showed a positive result in post-tests. This finding suggests that learning is a complex process, not adequately described by an input/output model. Learning may be a complex activity⁸. There may be limits to how closely learning can be planned. Learning implies a change in mental state. There are a number of researchers whose work attempts to trace the complexity of these changes, for example, Lawler [1985] demonstrated how mathematical knowledge develops within distinct domains and how significant moments of enhanced understanding are achieved when domains are bridged. The whole is more than the sum of its parts and the function of the learning is constrained by context. DiSessa [1988] argues that intuitive physics often conflicts with the text-book version. Non-physicists rely on a number of experiential fragments which he calls phenomenological primitives. These, he argues, require no explanation but are simply used without question. In order to enter the realm of scientific theory a more systematic model building is required. This layering of patterns of understanding is exemplified in Seymour Papert's [1980] computer language, LOGO, designed for exploring and developing mathematics and which capitalizes upon the dynamic aspects of learning. Change at the level of social organizations may also be a complex process. More recently, Black et.al. [2003] have used the findings of their meta-review of assessment to work on an action research project with teachers where the reflective process has been found to enhance the learning of both teachers and pupils.

⁸ Here 'complex' is used in the technical sense of Complexity Theory.

School-level Examples

Within schools, there is ample evidence that successful teacher development depends on extended time for reflection as in the action research model, Schon [1983], and that short-term INSET is relatively ineffective, (Askew and Brown, [1997]). Teachers' learning may also be a dynamic process. Fullan [2001a] identifies four main factors in the implementation of lasting change in educational systems. These are:

Active initiation and participation.

Pressure and support.

Changes in behaviour and belief (where changes in behaviour may predate those in belief)

The overriding problem of ownership.

A dynamic model of change is implied by the above factors. Louis and Miles [1991] found evidence that having 'effective coping strategies' was the most important issue in the success of change programs within urban high schools. This was closely linked to access to immediate information and feedback. The quality of planning was not related to the success of the programs. Scheerens and Creemers [1989] conclude that retro-active rather than pro-active planning is more important, that is, that schools need to plan generally but be flexible to plan in detail for immediate, changing circumstances. Earl and Lee [2000] emphasise the importance of 'just in time support' for the implementation of improvement projects.

Learning as Central to the Understanding of Education Communities

Within the school improvement literature there are examples of dynamic processes in action, such as John MacBeath's work with whole school communities. This work strongly implies a complexity model with its focus on community member

interaction and emergent solutions. Joyce [1991] captured the notion of a holistic and anti-reductionist approach to school improvement. Much of the theoretical work, however, returns to factor analysis, for example, Creemers[1994] provides a model containing a range of several dozen correlates with school effectiveness linked by arrows showing interconnection and influence. He then calls for large-scale studies to give greater empirical support for these links.

Some work in education leans towards a complexity approach. For example, Byrne and Rogers[1996] compare social and educational divisions using cluster analysis techniques. Tymms [1996] uses computer simulations to capture the 'ebb and flow' of performance data. The new statistical techniques associated with exploratory data analysis [EDA], are compatible with an approach which is interested in dynamics and in detail rather than averages and long-term trends. The above brief examples provide sufficient justification for embarking on an attempt to utilize Complexity Theory in educational contexts.

The most interesting area of work in education for complexity as I see it is round the idea of learning, change and feedback. This is almost certainly a complex process. Learning taken at different levels will end up covering large areas of interest within educational research. Various models of learning are in existence but the question that complexity could assist with is how levels of learning, pupil, teacher, organisation interlink. A complexity approach would attempt to identify behaviors which emerge from the exercise of local practices around teaching and learning and the possibilities of management structures emerging out of such local practices. The next chapter surveys the literature on learning and change.

Chapter 4 Literature on Learning and Change

To promote learning, it could be claimed, is the prime function of schools. I start this section by looking at the literature on learning at several levels. I move on then to consider 'change', again at several levels. Richmond and Peterson [1997] maintain that learning only occurs when changes are made to a mental model. To extend this idea, learning, change and improvement are linked if improvement is considered to be change undertaken as a result of learning.

Learning

The literature on learning is extensive. A positive link between school improvement and a school focus on teaching and learning is identified by many authors within School Effectiveness and School Improvement (SESI) literature, for example Gray et. al. [1999], Sammons et al [1995], Elmore [1995]. This section explores a subset of this literature which appears to be most relevant to the understanding of change and innovation in schools, school improvement and Complexity. I hope to show that these issues are closely linked. There is ample evidence to suggest that learning is a complex process (in the sense of being more than simple)⁹. It can be argued that school effectiveness is measured principally by how well pupil learning is managed, and that school improvement relates to increasing efficiency in this regard. It appears self-evident that learning involves change and that change is likely to involve learning. As Michael Fullan [1999] has pointed out, however, 'All improvement implies change, but not all change implies improvement.' As this chapter proceeds, I hope to show the relevance to my thesis of the readings I have selected in the areas of change, innovation and complexity. The material included in this chapter has all been influential in the development of my thinking throughout this project and has contributed to my approach to data collection, analysis and subsequent conclusions.

⁹ It is beyond the scope of this thesis to investigate fully whether all learning is complex in the sense of Complexity Theory, although this would be an interesting topic for discussion.

In order to explore the links, I wish to consider literature on learning under the following headings:

- Modes of learning and theories about learning.
- Levels of cognitive development and cognitive development at different levels.
- The variety of learning and what is left out of SESI studies.

Modes of Learning and Theories about Learning.

It is unusual to attend an In-service course for teachers at the present time where there is not some discussion of different types of learning; visual, auditory and kinaesthetic learning and some discussion of 'multiple intelligences', or the propensity to learn and develop in a particular area. It is claimed by Smith [1998] and others, that we have learnt in the past decade an enormous amount about how the brain functions, and that this should allow us to design better learning opportunities for pupils in schools. The notion of learning styles predates Smith by many years, for example, Pask's [1976] discussion of serialist / holist learning preferences and Kolb's [1984] four types of learner, have been influential in extending views on the variety of learning. The main value in these so-called 'accelerated learning' techniques and discussions of styles of learning may be to alert us to the fact that schools, particularly secondaries, have become too wedded to text-based and didactic approaches. As Senge [2000] points out failure at school is a form of exclusion. Large numbers of pupils in secondary schools in Britain fail to achieve the levels expected of their age group and are, by Senge's definition, excluded from possible future educational opportunities. This may be because a limited range of learning styles are catered for in schools.

Dryden and Vos [1999] outline four myths of education; school is the best place to learn, intelligence is fixed, teaching necessarily leads to learning and we all learn

the same way. These can be seen as a set of assumptions which teachers in school are beginning to question as they explore variety and diversity in the activities they provide for their pupils. The loosening of the hold these four myths have on curriculum design and teaching strategies in schools can be measured as a move away from more 'behaviourist' approaches and towards more 'constructivist', that is from a view of learning as passive to active and from an event to a process. In the past, SESI research may have relied too heavily upon behaviourist models of learning which has reduced its generalisability. The picture is complicated by the fact that 'learning' may refer at times to the acquisition of a piece of factual information, and at another time to a change in conceptual understanding. I intend to discuss some of the key elements of learning theories which have influenced the methodology of my empirical work in this thesis.

Wheldall and Merrett, quoted in Fontana [1984] represent a behaviourist position when they claim that 'changes in behaviour (i.e. learning) are governed primarily by the 'law of effect', that is, repeat behaviours which are rewarded.' Fontana goes on to point out that the advantages of this theoretical approach is that it can easily be operationalised since the concern is with observable events. Behaviourism can be seen as a form of empiricism and not as an explanatory theory. Often, however, it is construed as implying that humans (like lower forms of life) learn entirely by favouring those actions which are rewarded. Piaget [1978] attempted to provide some explanation of the process of learning in terms of what he called 'equilibration'. Extreme Behaviourism might be construed as establishing 'knowledge' bit-by-bit in the mind of the learner, without disturbing the prior knowledge base. To this extent learning can be seen as an event. Equilibration, however, is a process in which new information and ideas are assimilated within the learner's present understanding up to a point, at which there is a fundamental rearrangement or development of cognitive structures to accommodate these new ideas. Piaget proposed that this process is one of autoregulation by which the human seeks to minimise conflict and adapt to changes and therefore have a

greater chance of survival. The idea of autoregulation resonates very strongly with the Complexity Theory notion of a Complex Adaptive System.

The work of Piaget has been hugely influential. His ideas are central to the Cognitive Acceleration through Science Education (CASE) programme and its sister project in mathematics (CAME). Lessons within these projects are designed to lead the learner into the situation of cognitive dissonance¹⁰, that is, a set of new ideas and information can only be accepted by the learner if his or her underlying cognitive structures are changed. This notion of revolutionary progress rather than incremental accumulation is apparent in a number of fields. Lawler [1985], for example believed that he had identified separate domains of knowledge which then fuse and are transformed at significant moments of the learner's experience. At the level of collective understanding, Thomas Kuhn [1962] talks about revolutionary moments in scientific thought when the paradigm changes. Such revolutions are characterised by a change in underlying principles, for example during the change from Newtonian to Einsteinian physics. Complexity Theory is concerned, in part, with systems which experience radical change or phase transition.

Piaget emphasised developmental stages in the growth of individual cognition. Others have explored the importance of the context. Lave [1988] explored learning within a social and physical setting (situated cognition), Vygotsky [1986] prioritised the social over the individual in claiming that that social relations are converted into an individual's mental functions. These ideas are further developed by Lave and Wenger [1999]. Their phrase, 'community of learners' sums up the importance of the cultural influence and in particular that of language. They claim that 'learning is not merely situated in practice...learning is an integral part of generative social practice in the lived-in world.' [Lave and Wenger 1999, p86]. Lave and Wenger argue that learners are 'apprenticed' to communities of practice, becoming evermore a part of that community. The theoretical developments in this paragraph could be loosely termed 'social constructivist', since they retain the Piagetian

¹⁰ See Shayer and Adey [1981] Towards a Science of Science Teaching

features of cognitive reorganisation but emphasise the collective nature of this activity. Carnell and Lodge [2002] use the term 'co-constructionist', to focus on the detail of interrelationships and dialogue in learning.

Jerome Bruner [1964] considers, 'the techniques or technologies that aid growing human beings to represent, in a manageable way, the recurrent features of the complex environments in which they live.' In this regard he distinguishes, 'three systems of processing information by which human beings construct models of their world: through action, through imagery and through language'. My approach to the reading of literature on learning has been to assess the extent to which the complexity and dynamism of the experiences can be represented. Complexity Theory appears to offer some of the language and imagery to make this possible.

Levels of Cognitive Development and Cognitive development at different levels

In this section I consider some ideas about learning at the levels of pupil, teacher and school. Piaget proposes that individuals' cognition develops through stages from more concrete to more abstract, and that this is linked to the age of an individual, although strict links to age might be debated. Some argue that thinking can be categorised along a continuum from less to more sophisticated. Bloom's Taxonomy [1956] is representative of approaches to establish this continuum. Carl Bereiter [2002a] disputes this. He argues that Bloom's Taxonomy proposes a separation between thinking and content knowledge which he finds unacceptable since it does not take account of physical or social context. Mainstream education, however, subscribes to a hierarchy of thinking skills and places metacognitive skills at the more sophisticated end of the continuum. Metacognition is gaining increasing prominence in discussions about raising standards. As McGuiness [1999] points out, standards can only be raised when attention is directed to, not only what is to be learned, but also how pupils learn and how teachers intervene to achieve this. The Black and Wiliam [1998] work on formative assessment

highlights the importance for pupil progress on strategies designed to make those pupils aware of the stages in their own learning and what they need to do next to improve their work. It is possible that quite young pupils can reflect on how they learn. This contradicts linear views of learning promoted by hierarchies such as Bloom's Taxonomy and supports co-constructionism.

Watkins et.al [1996], [2001] discuss learning from the learner's viewpoint and distinguish between a Performance Orientation and a Learning Orientation. In the former, the emphasis is on attainment of specific levels of competence and comparisons with other learners. In the latter, learning as a process and strategies for learning are highlighted. Lodge [2001] developed these ideas further when she investigated Learning Discourses. In the 'More Meagre Discourse' learning is viewed as work; in the 'Richer Discourse' learning is prized for itself. In order to promote the richer discourse, Lodge suggests that teachers have to engage, among other things, in the sort of formative feedback favoured by Black and Wiliam above. The terms 'meagre' and 'richer' might appear unnecessarily judgemental, however this should not detract from observed differences in perceptions of learning.

The above authors discuss learning at the level of the individual. The emphasis on learning as a process is extend to whole organizations by Argyris [1999]. He claims that humans tend to operate with theories-in-use, which are tacit. When these lead to a conflict in practice with certain 'governing variables', then an organization is forced to reflect on the governing variables and the theories-in-use. Reflection, claims Argyris is not regular behaviour for organizations, but something that may be stimulated by questions from outsiders. Brown [1990] conducted a comparative study of two schools and noted that in the schools facing more challenging circumstances the staff were more proactive about change. This supports Argyris's claim above that conceptual change is a process of accommodation and suggests similarities with the notion of cognitive dissonance, discussed as a factor in

individual learning. As part of this thesis, it will be important to investigate similarities and differences between learning at different levels.

Leithwood and Louis eds.[1998] investigate Organizational Learning in schools and conclude that a school's capacity for learning is crucial to its ability to improve and that this revolves around an effective professional community within the school. In a professional community, according to Leithwood [1992], the staff collect information about and reflect upon their practice. An important feature of such schools is that leadership is distributed and is what Leithwood refers to as 'transformational leadership'. Issues of power, leadership and professional interaction are clearly important in discussions about learning in schools. Recent work in these areas has reached conclusions which could be seen as compatible with Complexity Theory, for example, Leithwood and Louis [1998] quote Weick and Westley who describe a middle way between too much and too little order. Silins et. al. [2000], in a large-scale study of leadership in Australian schools conclude that style of leadership does not directly correlate with improved pupil outcomes, but that high academic outcomes are linked to a collaborative school climate, a social climate in which teaching staff are encouraged to take risks and where relevant professional development is provided. An important issue is that leadership within the school facilitates the above. Margaret Wheatley [1999] emphasises that the most important role of the leader is to help the organisation to 'know itself'. These perspectives appear to be more in tune with Complexity Theory than traditional theories of management which prevail within education.

Teachers Learning: Effective Teachers and Effective Teaching.

Within organizations, the learning of teachers and the way they undertake their role is clearly highly relevant. In this section I discuss some views on effective teaching and on effective teacher learning. There is a growing literature on effective teaching and teacher professional development. My own approach within this thesis has been to argue that teaching can be judged to be effective only when pupils are learning effectively. I have made it clear to the teachers involved that the

main focus of this study is on effective learning in the first instance and on the multitude of factors, including teaching, which contribute to this learning. However it is pertinent to scan the literature to see what is being claimed with regards to teacher effectiveness since this will form a valuable comparison with emergent findings in my own data.

Views on what constitutes effective teaching depends in part on views of learning. there are a number of conflicting opinions in the literature. The management consultants Hay McBer [2000] have been commissioned by the Government to identify the factors associated with good teaching. Their study claims that the best teachers have high levels of professional characteristics, good teaching skills and good classroom practice. Each of these three apparently tautological headings is broken down into a detailed list. However, the list items appear as teacher characteristics and do not necessarily ensure pupil learning. In contrast to the Hay approach, Askew and Brown [1997] focused on effective teachers of numeracy which they found to be 'connectionist', that is favour making links across areas of the subject, have undertaken extensive professional development and have good subject knowledge. It could of course be argued that 'good' teachers are more likely to take up offers of professional development. Their analysis of effective teaching attempted to link teacher beliefs and behaviour with what might happen at pupil level. This approach is similar to that taken by J W Bloom [1999], who describes constructivism as 'the creation of meaning through spinning webs of ever greater complexity.' He urges us to focus on the 'patterns that connect' ideas in the process of learning.

In most of the literature reviewed the emphasis appears to be on defining a set of teacher behaviour and attitudes which a practitioner possesses. Creemers [2001] claims that effective teachers use a range of strategies including; modelling, coaching, scaffolding, articulation, reflection, exploration, generalisation, collaboration, anchoring present with past knowledge and have a strong goal orientation. Goddard et. al.[2000] take a less individual perspective and focus on

what they call 'collective teacher efficacy' which they have found correlates strongly with improved pupil outcomes. Goddard et al claim that collective teacher efficacy is an emergent property which they define as 'the group's shared belief in it's conjoint capabilities to organize and execute courses of action required to produce given levels of attainment.' Goddard et. al. [2000].

Not all authors subscribe to a universal set of characteristics defining effective teaching. Silcock [1993], for example, argues that the skills which make a good teacher are largely interpersonal and are to be found evenly distributed throughout the general population as a whole. This leads him to conclude that good teaching cannot be taught. Jensen [1995] notes that 'teaching is a high-risk career, if you are not taking a risk you are not growing and if you are not growing, neither are your students.' [Jensen 1995, p170]. Schon [1987] is also sceptical about universal models of teaching and teacher development, but for a different reason. It is the variety of the contexts and situations which demand 'a new theory of the unique case' to be manufactured through 'reflection in action'. According to Schon, 'there is not a single set of effectiveness criteria from which we might deduce competencies, but a constantly shifting classroom scene which teachers crystallize in order to control or influence.' [Schon, 1987, p68]. Schon's conception of teacher learning is the 'non-logical exploitation of tacit knowledge.' My motives in following up a Complexity Theory approach are in part to aid in the exploitation of such knowledge.

Effective Professional Development

When learning is considered at the teacher level the key word in much of the literature appears to be, 'collaboration'. Lortie [1995] quoted in Fullan [2001a], describes a large sample of teachers who were asked what they would do if given a gift of ten extra working hours a week. 91% said they would work on classroom and teaching related activities. This finding agrees with a perception survey conducted in Torfaen¹¹ in which the majority of teachers claimed that collaborative

¹¹ Perception Survey was part of the recent Best Value Review in the LEA

working was the most important In-Service activity. Certainly collaboration and partnership figure in many of the accounts of sustained teacher development. Frost et. al. [2000], describe their teacher network and its development over more than ten years. The most important set of conditions leading to school improvement, they claim, is teacher development through the nurturing of a critical discourse, which reinforces Shon's point in the last paragraph. They believe that school, LEA and Higher Education partnerships are an integral part of establishing such a discourse. Hargreaves [1998] emphasises the importance of creating professional knowledge, including the transformation of tacit to explicit knowledge, which supports the importance placed by Frost et. al. on the sharing and articulating of teacher knowledge. The 'deprivatisation of practice' is one of the elements of effective Teacher professional development emphasised by Kruse et. al. [1995], along with reflective dialogue and a collective focus on student learning.

Effective professional development is regarded by many writers as a long-term and dynamic process as the following examples show. Eraut [1982] emphasises that, from his studies, effective In-Service has to be sustained, intensive and provide individual support in the classroom. Fullan [2001a], includes the previous points in his important principles for teacher professional development, but adds that there needs to be support for informed dissent and that the relationships and context within which the professional activities take place are extremely important. Elmore and Burney [1999] claim that successful professional development:

- Focuses on concrete classroom applications of generalities
- Exposes teachers to actual practice rather than descriptions
- Provides opportunities for group support and collaboration
- Involves deliberate evaluation and feedback by skilled practitioners.

These points are reinforced by Hopkins [2001] quoting Joyce and Showers [1995], who reviewed a large number of studies of effective teacher professional

development and concluded that the following components of training, when used in combination, have a much greater power than when used alone:

- The presentation of theory or description of skills or strategy
- Modelling or demonstration of skills or models of teaching
- Practice in simulated and classroom settings
- Structured and open-ended feedback
- Coaching for application (hands on and in-class assistance with the transfer of skills and strategies to the classroom)

Reading a representative sample of the literature served to emphasise for me that trying to understand learning within schools would include listening to the views of teachers about what was effective for them. It would also be important to bear in mind that the what and the how of learning varies considerably within and between schools as Joyce et. al. [1997] emphasise. In response to the perceived need for different learning styles and curriculum requirements to be catered for, they have identified a number of models of effective teaching.

The Variety of learning, what is left out of SESI studies

Although this thesis aims to deal specifically with applications of Complexity Theory to educational settings it is important to consider that these operate within a wider social context. Pupil and teacher learning is not the sole preserve of the school. Although there will not be space in this thesis to address this fully, it is important to highlight some of the issues with reference to SESI and related literature. School Improvement studies tend to prioritise academic attainment and progress, although these are often accompanied by attitudinal data. Early studies by Rutter et al. [1987] established a benchmark for the addition of contextual and non-academic data. Although academic attainment may be the focus of attention for some sectors of society, it is not the only area of learning which is important. As Abbott and Ryan [2000] point out, only a small fraction of a young person's waking life is actually

spent at school. Out-of-school learning may not only fill more of a young person's time, but may, as Bentley [1998] claims, increasingly provide more relevant learning opportunities than the school. As mentioned by Lave and Wenger [1999], schools sometimes assume that they provide learning divorced from external contexts. Far from being decontextualised, schools provide a different context which some argue may become increasingly less relevant. Stoll and Fink [2002] quote the UNESCO who claim that priorities in the twenty first century are to learn how to know, to do, to live together and to be. Schools in the future may increasingly be judged on points three and four of these. Carl Bereiter [2002a] explores the tensions between learning in school and in work. He distinguishes two types of 'knowledge work', within; Belief Mode and Design Mode. The first is about deduction and 'certainty', it reflects the outward face of learning and academia. Most text-book based learning and work in schools operates within this mode. Design mode, according to Bereiter, comprises trial and improvement, looking for the use value of an idea, amending and refocusing goals based on feedback. Scientific and business teams actually operate within this mode, although they might publish their final report in belief mode. Bereiter calls for more 'design mode learning' within schools, since this develops skills essential for the Twenty First Century. To quote the title of a recent address by Professor Bereiter, 'The only important 21st-Century skill is working with knowledge itself.' Bereiter [2002b]. Cast in Bereiter's terms, Complexity Theory applied to social systems could be construed as being concerned with the occurrence and process of design mode learning.

Much SESI literature reports on statistical correlates. This may not provide sufficient detail about learning and may, in some cases, lead to false assumptions about what are the best strategies to follow. Many School Improvement studies link 'time on task' to increased pupil progress. The question of how that time is being spent is also important. Boaler [1997] made a careful study over time of two contrasting secondary mathematics departments. One promoted a traditional, didactic model of teaching where pupils were set and where quite a strict regime of

model examples followed by practise was adhered to. The second school organised classes by mixed ability and used a more project-based approach with pupils often working collaboratively on longer tasks. The didactic department kept it's pupils at work for a greater length of time in lessons. In the project-orientated classes, pupils were more likely to be 'off-task' for extensive periods. Overall findings suggested that pupils in the two departments made similar progress against National Curriculum levels. In the project-orientated classes, however, pupils expressed more positive attitudes towards mathematics. In the same school, Boaler argues that more able girls achieved more than their counterparts in the didactic school. The reverse was true for more able boys. Boaler explains this by reference to the girls' need to understand which was denied them in the didactic school. More able boys were operating more at the level of internalising examples without full understanding and then moving on. The point is that what happens while on task may be as important as actual amount of time. Csikszentmihalyi [1991] describes what he calls 'being in a state of flow' as an individual's sense that time is suspended and that the sense of self is lost. This 'optimal experience', as Csikszentmihalyi calls it, may be a time of rich learning experience, and worth cultivating and hence a focus on quality of engagement rather than quantity may be important.

Some SESI researchers do place learning at the centre of their investigations. Hargraves, quoted in Silins et. al. [2000], for example, claims that deprivatisation of teacher practice and the taking of collective responsibility for student learning are key factors in school improvement. In 'The Intelligent School', MacGilchrist et al [1997] explore teacher and pupil learning. Paul Clarke [2000] claims to detect a move in educational thinking towards a 'non-linear paradigm'. Perhaps one in which the language is not yet established. Clarke claims that each school needs to forge its own solutions within the 'rich swirl' of complex factors which are normally present in schools. Successful schools, he argues, exhibit the behaviour of Complex Adaptive Systems. Comments such as these spurred me on to look for ways of investigating Complexity Theory in practice. Dimmock [2000] suggests

starting with the learning and mapping backwards to the structures of the school. I have taken this advice literally in an attempt to develop a Complexity Theory approach, as will be described in later chapters.

Change

In this section I survey the literature and discuss the what, why and how of educational change. I refer also to some of the writers in business contexts who are starting to make an impression upon the education scene. My reading shows that some authors in the field of business management have been exploring the implications of Complexity Theory for their area of interest over a period of at least ten years. Only recently has this quest been taken up by a small number of education researchers and writers. The examples cited from both contexts below have influenced my decision to explore the topic further and influenced the design of my study.

I have divided the topic of change up into the following sections:

- What changes and why?
- How does change take place?
- What is the role of the Education Authority in change in schools?

The last of these sections is important in addressing the aims of this thesis, namely to move towards establishing more effective working practices for the Advisory Team.

What Changes and Why?

Lord Salisbury is reputed to have said 'Change? Who needs change? Things are bad enough around here already.'¹² This sums up the feelings of many people working in education. Teachers often express alarm at the number of new initiatives which they are expected to accommodate and implement. Demands are

made on school teachers from a number of sources; the Government, senior school managers, parents, governors, the pupils and other colleagues. These demands are often unconnected and this leads to the feeling of frustration around the issue of change. Having said this, most teachers I work with clearly wish to improve their professional skills and are keen to help their pupils progress more effectively.

So is change useful or even necessary? The short answer may be that it depends on the type of change. Fullan [1991], for example, argues that school improvement depends in many cases on there being a fundamental change in culture. He claims that structural change is easier to effect but is largely short-term and often cosmetic. In essence, the culture which Fullan envisages as being a prerequisite for long-lasting improvement is one in which teachers work collaboratively as reflective, self-motivated professionals. He points out that collaboration is not, in itself sufficient, since teachers being organised into working groups often leads to what Andy Hargreaves calls 'contrived collegiality'. Fullan notes that collaboration can lead to a reinforcement of ineffective practice. His view is that educational change is 'Technically simple and socially complex.' Fullan [2001, p69]. To address this complexity the main focus, according to Fullan, should be on defining meaning, establishing connections, coherence and developing relationships. 'Substantial reform (is achieved by) persistently working on multilevel meaning across the system over time', Fullan [2001, p 80].

The type of change which Fullan has in mind is clearly not a matter of providing a quick fix. Senge [1999] points out that short-term solutions often prevent more substantial change from taking place. But why should radical change be required? A common argument is that the world is changing rapidly and that the skills young people need in the twenty first century are fundamentally different from those required in the twentieth. (see Abbott and Ryan[2000], Bentley [1998], Barber [1996]). Stephen Hawkins [2001], for example, points out that information is

¹² Quoted in Bennett and Rolheiser [2001], p18

expanding 100,000 times faster than biological expansion. There may be evidence to support claims about the need for educational change on the grounds of changes in the work place. In my view, there are more fundamental reasons which relate to the way living systems operate. It is the discussion of these issues which come to the education field from business literature and which, I believe, deserve our careful attention.

The detail of Chaos and Complexity Theory is discussed in Chapter 3. It is these, along with Systems Theory and ideas from biological evolution that have been influential in business literature. Stacey [1996] argues that 'change is what living systems do'. He proceeds to argue that social systems, like biological organisms, are in a state of continuous adaptation to their environment. A business organization attaining a state of equilibrium, argues Pascale [2000], is tantamount to that organization signing its own death warrant. Organizations either grow and develop through creative interaction with their environment or they stagnate and die. This view is of change as 'the normal state', but not random change or change at any price. Stacey [1992] and Stacey et. al. [2000] suggest that the most flexible, creative and successful companies are 'operating on the edge of chaos'. That is, mid-way between too much structure and too little. This is not to say that everything is open to change. Organisations (like organisms), may work hard to maintain their identity, a principle referred to as autopoiesis. According to Heifetz [1994], 'People do not resist change, they resist loss'. In order to preserve its identity, a social organization may make widespread changes to some aspects of its structure or operating procedures. There is agreement about successful change and change as a learning experience expressed in both educational and business contexts above. This justifies, in part, the exploration of Complexity Theory, found previously to be useful within business settings, within education.

How Does Change take Place?

If change is to be expected under normal circumstances, then it makes sense to organize around continuous change. Again the business literature provides useful insights. As Mintzberg et al [1998] argue, 'the best way to manage change is to allow for it to happen'. This is significantly different from the traditional view that change has to be carefully planned in every detail. A major issue here is around who is in control. In a traditional, hierarchical organization (such as the car assembly plant) the senior managers may have two concerns. First, are the bulk of the employees willing or able to take responsibility for an area of production and second, can control over the process be maintained if each step is not carefully monitored? The shortcomings of such a traditional approach are numerous. As complexity increases it becomes impossible to monitor everything. Perhaps even more of a concern is the fact that the organization is inflexible and finds it difficult to change in the face of changing circumstances. Not being in control does not necessarily mean that one is out of control (as Gunter [1997] points out). The so-called post-fordist thinking in business circles acknowledges the energy and creativity which is released by empowering self-managing teams of workers. Stacey [1992] characterises the old mind-set as one which prizes stability and seeks to reduce anxiety and disturbance. Change provokes anxiety. The new mind-set, according to Stacey, emphasises a focus on the organization learning from itself and others, and on managing anxiety. The importance for successful change of teachers working collaboratively within a learning culture is emphasised by many writers. Fullan [2001a] claims that collaborative working is important for helping to manage the anxiety which change generates. Gergen [1990] summarises the situation as follows:

'...the problem (for organizations) is not to discover a 'rational' course of action, a fixed form of management, but to expand the alternatives for action in a world of ever-changing and unpredictable demands.' My intent in this thesis is to investigate the relevance of this non-linear analysis to education.

Education in this country still maintains a hierarchical structure and the old mind-set that goes with it. Which may explain why many educational reform initiatives fail. Fullan [2001a] claims that many which fail are 'hyperrational'. The recent National Numeracy (NNS) and Literacy (NLS) Strategies represent a whole-scale attempt to raise standards in numeracy and literacy in England. Michael Fullan heads a Canadian team who are evaluating the success of the strategies. He acknowledges that success has been achieved in boosting test scores at the end of primary schools. He believes that the government-sponsored strategy team has provided a rigorous system of accountability and incentives to improve in the form of materials and professional development. Accountability and incentives he sees as two of the three main features underpinning successful long-term change. The third is building capability. Fullan believes that the long-term success of NNS and NNL depends upon whether or not teachers will be placed in the driving seat of future developments.

Bascia and Hargreaves [2000] claim that 'Education reform fails to understand the depth, range and complexity of what teachers do.' The question is whether this complexity is such that the new mind-set is more appropriate in education than the old. Many writers think so. Earl and Katz [2000] believe that 'getting teachers deeply involved in envisioning and managing change means giving up the idea of a preconceived outcome... and abandoning the notion that there is one best way to teach.' As has been discussed, the importance of putting learning first and on collaborative learning is emphasised by many writers within the education and business fields. Nonaka and Takeuchi [1995] highlight the importance of 'organizational knowledge creation and sharing' by colleague interaction, dialogue, reflection, networking and through action. Fullan [2001] quotes Elmore and Burney [1998], in their analysis of the success of reform in District 2 in New York, who point to a singular emphasis on instruction, and claim that teachers sharing their experiences was the main driver of instructional change. Fullan [1999] quotes Stacey [1996] who notes that living systems cannot be assembled, but have to emerge. Rather than detailed plans, what is required is effective support through

the provision of materials, assistance and support for developing capacity. Morgan [1997], uses the brain as a metaphor for organization. He regards it as possible that 'in brains, 'intelligence' emerges from the activity of simpler units which learn their way forward'. In order to understand how such capacity is built it will be appropriate to use data collection techniques which might reveal some of the detail of learning at different levels.

FitzGibbon [1996] acknowledges that schools and teams within schools are able to become self-improving. She points to effective monitoring as a key to this process. By monitoring a set of appropriate performance indicators, the focus of the organization is brought to bear on these and measures to improve them follows. Feedback is important for improvement. FitzGibbon also points out that in social systems feedback can be in the form of dis-information. This is not the case, she claims, in physical systems. Her solution to the information problem in education is two-fold. To establish a large-scale individual pupil-level database so that monitoring can be carried out and to instigate a programme of randomised control trials (RCTs) in key areas to establish a 'factual' basis for knowledge about educational communities. Although FitzGibbon's point about requiring accurate information is clearly a valid one, it is not certain that RCTs will provide this. My argument in this thesis is that in complex situations, techniques from classical physical science may not be appropriate. Fitzgibbon [1996] suggests that the role of senior managers in schools is to provide the information infrastructure to allow local problem solving to be effective. The point that I believe she misses is that in complex situations control of variables is impossible in principle.

Leadership roles are discussed at length in educational (and business) texts. The new mind-set suggests a flatter management structure where the leadership role is distributed and transformational (Leithwood [1992], [1998]). Zuboff [1988] sums this up, in the new structure, 'hierarchies are more fluid, in line with the needs of information rather than older notions of rank.' Fullan and Senge support a similar view. Fullan notes that effective principals, 'nurture a subtle process of enabling

teachers to work together to generate solutions.’ Fullan [1997]. Senge’s view is that ‘the leader’s task is designing the learning process.’ Senge [1999, p345]. Stacey [1992, p207] and Stacey et. al. [2000] claim that ‘organizational structures are largely irrelevant to the emergence of new strategic direction’. Which supports the view above that ideas, information and inter-personal relationships are the key to managing change. These views also fit with the earlier discussion about what should change if school improvement is to be achieved, that is, cultural change is more important than structural. It is clear that views of change and effective change management which are compatible with Complexity Theory have been expressed in the business literature for some time. From my position as an Education Adviser it will be important to consider my role in the process.

What is the role of the LEA in the change process

The Audit Commission and OFSTED [2001] conducted a large-scale survey of the effectiveness of 91 LEAs in England by looking at inspection judgements from Local Education Authorities. One of their key findings was that there is little correlation if any between the quality of the work that the LEA does and raising standards of pupil achievement. The exception to this is in the areas of literacy and numeracy, where huge levels of support have been provided. This poses questions about the value of outside support and for the future of LEAs. There are, however, a number of sources which support the need for an agency external to the school in the promotion of change for improvement. Some of these are discussed below.

Black and Wiliam [2000] point out that ‘standards are raised by changes which are put into direct effect by teachers and pupils in the classroom’. Since whole-school organisation must also be considered, the LEA influence is likely to be two steps removed from raising pupil standards. It is therefore not surprising that statistical techniques show no direct correlation. Silins et. al. [2000] show that school leadership influences pupil outcomes through a variety of other factors but that there is little direct correlation between leadership and pupil attainment. It could be argued that the work of advisers is even further removed. In a study of one school

for my Institution Focused Study (Cunningham [2000]), I argue that a whole set of conditions come together within the school to promote higher achievement. I used Harland's [1988] categorisation of the work of advisers to argue that constructive criticism from outside is accepted by schools only after a period of trust-building. Some of the work of advisers may appear to outsiders to be unconnected to raising pupil standards, but often it has to do with working on relationships and on building the capabilities and confidence of teachers. It is not clear that the 'hidden' aspects of advisers' work are built into the judgements about quality.

Ainscow and Howes [2001] point out that there are five key areas of work for advisers in LEAs. These are: school improvement, monitoring, target setting, sharing best practice and intervening in and supporting schools causing concern. They have undertaken a detailed study of an LEA which is judged to be very good on OFSTED criteria and which involved work shadowing advisers over time. They found that much of the trust-building work which advisers do goes unrecorded, partly because it does not fit with the rather hard-edged performance indicators against which advisory work is judged. Block, quoted by Fullan [2001. p 191] points out that a good measure of the work done by external agents is the measure of the, 'optimism and self-sufficiency left behind'. This may also apply in part to advisers. School perception surveys of adviser effectiveness and satisfaction with the support given by advisory services are usually very positive, as has been the case in Torfaen. The upshot of all this is that official inspections may not include all the important factors in their judgements about quality, and the benefits of advisory work may indirectly influence pupil standards.

There is substantial support in the literature for the role of outside agencies in working with schools. The most popular model appears to be that of a 'critical friend' who also facilitates and promotes cross-school networks and communities of practice. MacBeath et al [2000] emphasise the need for this external perspective, drawing on school improvement projects across a number of European countries. Earl and Lee [2000] highlight 'Urgency, Energy and Agency'

as the three key ingredients for a successful change project in schools. The third of these involves the support of external agents in a 'just in time' capacity which they describe as being available to support and ask the right questions at the right time rather than to 'mastermind' the work. There are clear similarities here with the teacher who asks the critical question of a pupil to move that person on in their problem solving. Fullan [2001] claims that the three key roles of the district or LEA, to provide; accountability, incentives and capacity building. In order to succeed in these tasks, he suggests that data is used for improvement and not embarrassment and that capacity building is put before compliance. Harris [2001] further supports this. She identifies four dimensions of the LEA adviser's role which support change in schools:

- Bridging or brokering – building links within and between schools
- Participative and transformative activity
- Coaching or mentoring
- Liaising or representing with other agencies

To summarise this section on change, there is strong agreement among a number of authors both within the fields of education and business that successful change occurs when employees are working in effective learning communities. As Elmore et al [1990, p 97] point out, the key to establishing a learning ethos is that, 'teachers are required to redefine themselves as learners.' Elmore [1995, p20] has also claimed that 'Small groups of self-selected reformers seldom influence their peers'. Professional learning communities must include most of the teachers/employees. It may not be essential that everyone understands the course of action to be taken from the beginning. Fullan [2001] points out that clarity comes with action and that good solutions to problems often emerge over time. Stacey [1992, p101] calls for, proaction and reaction to be replaced by continually creative interaction. In the words of Helen Gunter [1997, p 108] 'People don't just respond to their environment, they create it.' Education and school environments are continually changing. The task suggested by many of the authors above is to explore the activity associated with change further and to find ways of drawing all teachers into the process. Insights from Complexity Theory may facilitate this.

In conclusion to this chapter I will briefly summarise the main influences which shaped the development of the methodology for this thesis:

- a) Change within organizations appears to be the 'normal' state of affairs.
- b) From reading the literature on change it appeared to me that improvement was not only linked to learning, but also, in the long term, to learning about learning. It was clear from the literature that school improvement is closely linked to a school's capacity for learning. Key questions in the development of methodology, therefore, centred on learning at different levels.

Given the two points above I realised that it would be productive to focus on learning.

- c) Recent discussions about 'learning', as described in this chapter, define it as a process which is complex, constructive and often social.
- d) An attempt to identify Complexity features would usefully involve teachers, pupils and schools managers and to investigate their views and practice around issues of learning. This would comprise some form of observation and discussion with a possibility of feedback and further reflection and amendment.

I wished to undertake this work in a way which:

- e) Would not add to teacher stress, and
- f) Would work to promote learning within the institutions studied.

This was further supported by views that Local Education Advisers are most effective when they adopt the role of a 'critical friend', and that this depends to a large extent on the building up of trust between adviser and teachers. Further to this:

- g) The business literature on change appeared to confirm that 'new management structures' in some businesses, take account of the importance of individual and of organisational learning.

The next chapter outlines the practical development of methodology and approach taken in the project.

Chapter 5 Methodology

Introduction

A fundamental question for me throughout the work on this thesis has been to decide what methodology is appropriate for establishing whether aspects of Complexity Theory are applicable to educational contexts. In surveying the literature I was keen to identify techniques and approaches that appeared to be compatible with Complexity Theory. I was also aware of my role as a school development advisor, and the fact that I would probably face a potential conflict of interests between my role as adviser and that of researcher. As discussed in the previous chapter, a focus on learning appeared to offer the best opportunities for an exploration of the relevance of Complexity Theory. As will be explained, I decided upon three related methodological approaches for this thesis, for reasons which I hope to make clear.

The first was the use of Exploratory Data Analysis (EDA) techniques with available quantitative data (described in chapter 7). This approach to analysis appeared to me to be more compatible with Complexity Theory than classical statistical techniques since it allows simultaneous focus on different levels in the data and the further investigation of interesting single cases. The second was the development of what I call 'Learning Episodes', their use with individual teachers and groups of teachers in schools (described in chapter 6). This again was an exploratory technique. The completed Learning Episodes acted as a stimulus for discussion rather than as a comprehensive record of aspects of learning in the classrooms under study. As will be explained later in this chapter, I hoped to publish these for teachers in a form which would allow the Learning Episodes to evolve in line with Complexity Theory expectations. In the first instance they were used in discussion with teachers. Given the time-scale of the thesis, and the fact that such evolution would require a relatively long period, I decided to augment the Learning Episodes with interviews, to support views on learning documented in the Learning

Episodes. These were conducted around the time of the learning episode observations and led to a third set of analyses. This third approach comprised the analysis of interviews about learning conducted with pupils, teachers and senior managers in three schools (described in chapter 8). I decided at this stage to focus on the interviews rather than the Learning Episodes for this detailed analysis since they represented a more authentic set of views than the Learning Episode material which, in the early stages, largely represented my own perspective. In the future, Learning Episodes refined and rewritten during an evolutionary process would merit careful analysis in their own right. These approaches developed out of a process of reading, data collection and attempts at analysis which were then subjected to criticism. This was itself an emergent, dialogical process which continues to be refined as I work with teachers. The issue of what would constitute appropriate methodology was not clear at the beginning of this thesis. Much of my work in the project involved an exploration of possible methodologies. I have attempted below to outline some of the key influences on this work and the key stages in its development. I begin this chapter by discussing the ethical issues which concerned me when starting on the project.

Ethical Considerations

As an Adviser undertaking research within my own 'patch' there were a number of important issues to consider. I knew that teachers would react to me as an adviser and that this would be different from some unknown 'researcher'. I decided at the outset of this project on a number of key principles to which I would attempt to adhere:

- I wanted to remain working as an effective adviser in the area during and after the study.
- I wanted pupils, teachers and schools to benefit from the work and not to feel threatened by either the methods used or the outcomes.
- This did not mean that no negative comments could be made, but that the emphasis should be placed on starting with the positive and on building

teachers' confidence through acknowledgement of the work they are doing and valuing this.

Advisers are perceived by teachers to be in a position of authority. In reality this authority may be less than teachers believe, however the perception of this authority certainly influences how teachers behave. Having someone from 'County Hall' in your classroom may intimidate some teachers and make others determined to put on their best show. A further group of teachers may simply continue confidently with their work and may actually welcome the opportunity to discuss aspects of it. Advisory work appears to be most effective when there is a high level of trust established between the Adviser and the school. (Harland [1988]). There appeared to be two main concerns related to preservation of this valuable trusting relationship. First, during the research, there might be a conflict between the 'objective' research role where uncomfortable judgements about practice might be made and the supportive 'critical friend' role which involves someone who helps a colleague to build on their strengths and gradually minimize their weaknesses. Second, when outcomes of the work were made public, there might be repercussions within the Authority when comparisons were made between schools. Regarding the first issue, I decided that an Appreciative Inquiry approach described later in this chapter would be suitable for this project. I reasoned that this would encourage teachers to take part in discussions about effective learning. I also reasoned that teachers reflecting on their own practice and amending their subsequent actions was compatible with Complexity Theory ideas. Concerning issues of final publication of reports, I decided that individual teachers and schools should of course be made fully aware of the research as it progressed, but that anonymity of schools and teachers should be maintained in any final report. Although schools might identify themselves within such a report, it would be emphasised that the techniques are exploratory and designed to lead ultimately to more effective advisory practice. This approach appeared to solve the key ethical problems faced in the project.

Key Influences on My Approach to Data Collection and Analysis

As previously discussed I intended to explore the possibilities of using qualitative and quantitative data in the project. In this section I outline some of the key influences on my development of appropriate methodology of both qualitative and quantitative data.

Influences on My Approach to the Use of Quantitative Data

To start with a negative influence, I decided early on that neither classical statistical analysis of pupil performance data nor reductionist and correlational approaches would reveal features of Complexity Theory, although these statistical tools and assumptions appear to be firmly embedded in the minds of some Government policy makers. David Blunkett, the Secretary of State for Education at the time of writing, discussed the type of educational research that he believed we need:

One of our prime needs is to be able to measure the size of the effect of A on B. this is genuine social science and reliable answers can only be reached if the best social scientists are willing to engage in this endeavour. (Blunkett, [2000], p20)

This suggestion struck me as an example of the antithesis of a Complexity approach. Although there is not room in this thesis to delve fully into the debate about appropriate methodologies in social science, I will point to a few considerations (to add to those in the earlier section on SESI research) which convinced me that Blunkett's suggestion was not one that I should follow. The first originates from practical attempts to provide what some people would regard as a solid basis for educational research. This is reported on by Budge [2002] and concerns a Government funded project based at the Institute of Education in London, the EPPI-Centre (Evidence for Policy and Practice Information Centre) which is charged with the task of reviewing research and extracting solid findings upon which education policy can be based. Early work has proved disappointing to some politicians who had hoped for clear generalisations. Much of the work reviewed has been undertaken by established social scientists. The inability to find generalised laws linking 'the effects of A on B' strongly suggests that findings in

education may be highly dependent on a range of contextual factors. This is supported by outcomes of research undertaken with the assistance of advanced statistical modelling software. For example, Gray, Goldstein and Thomas [2001] investigated A and AS level results for a very large data set over four years, matching pupil outcomes to their GCSE scores for individual institutions. They discovered that the raw results achieved at institutions was relatively stable over time. When prior attainment was taken into account (hence effectively measuring pupil progress), they found a different picture. Pupil progress could be used as a measure of institutional effectiveness. Gray et. al. found very little stability in pupil progress scores. Those trends that they did find were short-lived. They concluded that very few of these institutions were becoming more or less effective over time, and this in a climate where there is enormous pressure for improvement. This finding is similar to that of Gomm and Hammersley [2001], who concluded that the maintenance of pass rates over time had much to do with staff perception that a certain percentage of students should achieve each grade.

A second consideration relates to statistical techniques and their use. Griffiths [2002] discusses two common statistical fallacies. The Atomistic Fallacy, where results obtained at one level are assumed to be replicated at another, and the Ecological Fallacy, where group-level results are assumed to give a measure of the proportion of individuals obtaining this result within the group. It is only recently that computing power and access to pupil level data tracked over time has made it easy for these two fallacies to be avoided. The statistical techniques used by Gray et. al.[2001] escape the Ecological fallacy, although the multilevel techniques used may still be open to the Atomistic. These considerations, however, led me to speculate with Griffiths about appropriate statistical techniques for studying school effectiveness and school improvement. Byrne [2001] goes further and argues that although the multilevel techniques now commonly in use allow the handling of compositional effects they cannot detect emergent features and it was these in particular that I wished to identify if present.

Alternative Approaches to the Analysis of Quantitative Data

David Byrne uses quantitative data but avoids classical statistical techniques within an approach he calls 'Complex Realism' (Byrne, [2002]). He draws on the work of Ginzburg who attempted to establish local and specific chains of causation in order to explain particular event in what he called a 'science of clues'. Another of his influences is Znaniecki who makes comparisons between individual cases and from this develops hypotheses which are continually reformulated. The practical outcome of these considerations is that Byrne uses statistical packages in unusual ways that rely more on the Exploratory Data Analysis methods of Tukey [1977] and Marsh [1982], [1988]. Cluster and cross-tabulation analyses become the main-stay of Byrne's work. He attempts to establish clusters where there is a minimum of variation between members of the cluster and a maximum of variation between clusters. He also attempts to track the trajectories of individual cases over time, particularly noting when they move between clusters. Byrne notes that the term hierarchy is misleading since if clusters are nested and interrelated there is a mutuality suggesting that the parts and the whole are equally important. Byrne's interest is focused on cases rather than variables. Variables are seen as indicators of the character of the system. He attempts to plot changes in the system over time and explore the relationships between levels, viewing the context as an integral part of the system. Byrne argues that important features of the system cannot be factored out, but that emergent features can be explored by simulation (Byrne [1997]). He claims that simulation models of complex systems must themselves be complex, which raises the issue of what such a simulation might look like, and whether it would be any easier to handle than the phenomena it was modelling.

The Possible use of Dynamic Software Analysis

A number of simulation tools have been developed within a business context. I explored the possibility of using one such called STELLA. The principle author of this software outlines the philosophy behind it, which has a strong systems thinking bias. According to Richmond et. al. [1987], STELLA is designed to build understanding and the capacity for sharing understanding by simulating the interplay of variables over time. Richmond believes that this avoids what he calls

the 'laundry list' approach where a set of factors are identified as principal causes (or closely correlated with an outcome). In further discussion of the background to STELLA, Richmond and Peterson [1997] outline the assumptions behind systems thinking. These are threefold. First, that the system itself is part of the causal network. Second, that to work with a system requires what he calls 'operational thinking', where appropriate levers are manipulated to promote change within the system. Third, systems generally involve feedback, positive and/or negative which have a reinforcing or dampening effect. Richmond claims that STELLA allows us to maintain a 'bifocal vision', a close-up, detailed view of the present and a distant over-view of system developments. The software handles the translation of one to the other. STELLA, and other dynamic modelling software could well have potential for exploring educational systems. I did not, however, believe that this would be within the scope of this thesis. I was concerned about the realist aspect of Byrne's agenda but believed that I could use some of his clustering techniques without necessarily subscribing to a set of realist assumptions. Cluster analysis is utilised in chapter 7 where a number of parameters are considered together with the identification of a resultant set of six common 'types'. Cluster analysis is also used in chapter 8 where a first attempt is made to identify strange attractors. The K-cluster facility in SPSS is used alongside manual methods of coding and grouping in order to explore the possibilities of using SPSS with larger data sets.

Influences on the Analysis of Qualitative Data

It was clear to me that some form of grounded approach would be appropriate when dealing with qualitative data. I was worried, however, about possible conflicts and tensions which might arise between my roles of adviser and researcher, particularly if I took a judgemental approach. Further reading was undertaken to see if such conflicts could be avoided. There is a wealth of literature on grounded theory. Glaser [1992] appears to be representative of this. His concern is that categories should not be forced on to the data but should be allowed to emerge. Well constructed grounded theory then fits the events under study, works to explain variation, is relevant to participants and researchers and is modifiable.

Further consideration and reading in the area of Action Research convinced me that a model such as that of Elliott [1991] which includes planning, action to implement, evaluation and reflection on the next step would be most appropriate. This is not unlike the approach taken in many school improvement projects. The difference is that my approach is not limited at each stage by assumptions of linearity and to interventions born of a reductionist methodology. The planning stage emphasises dynamic feedback loops rather than linear steps and the action and evaluation stages draw on insights from Complexity Theory. I was interested in bringing about change and wanted teachers and pupils to be at the centre of this. In this regard Zuber-Skerritt [1996, p3] defines 'Emancipatory Action Research' as 'collaborative, critical and self-critical inquiry by practitioners' and that such activity is aimed at changing the system itself or conditions which impede desired improvement. Hence the project was to enable me to change my practice and feel in control of the changes and to encourage and assist teachers towards the same aims. Clearly the project was originated by me and did not arise out of a problem expressed by teachers, however, an emphasis on learning connects with an ongoing concern of most teachers, that is how to promote the learning of their pupils. It would thus be seen as an important and relevant issue by teachers. David Kember (2000, p24) defines Action Research as:

- Concerned with social practice
- Aimed towards improvement
- A cyclical process
- Pursued by systematic enquiry
- A reflective process
- Participative
- Determined by the practitioners.

As will be demonstrated, the development of the use of learning Episodes in this thesis meets the majority of Kember's definitive features of Action Research.

Since I wanted this work to be emancipatory, I was concerned at this stage with how the data would be collected and the perception of the teachers in schools of

the purpose of this data collection. Although the school development adviser role in Torfaen is largely a supportive one teachers understandably still have misgivings about having advisers in their lessons. Appreciative Inquiry appeared to be an approach which might allay some of these fears and persuade teachers to participate effectively. Bushe [1995, p 15] explains that Appreciative Inquiry, 'treats social and psychological reality as a product of the moment, open to continuous reconstruction.' Essentially the approach is about emphasising the positive and endeavouring to persuade people to move towards the best. Bushe [1995] claims that attempts to represent the way things are merely traps us in a 'rear-view world'. He sees it as important to tap into the energy that is released when people concentrate on the positive. Bushe [1995, p16] outlines four steps in this process:

- Start with the best of what is
- Collaboratively articulate what might be
- Ensure consent about what should be
- Collectively experiment with what can be

I did not want to fully subscribe to the Appreciative Inquiry method but saw value in the positive approach and could see how it would fit with ideas from systems thinking and Complexity Theory. I have argued that the key issue in education is learning. Teachers express interest in discussing the learning of their pupils. I therefore took the approach with teachers of suggesting that we work collaboratively to collect examples of where pupil learning was effective and try to tease out the reasons why this was so. A full description of this approach is given in a later section. Basically the units of data collection or Learning Episodes as I called them would then be available for collective scrutiny and discussion (given the consent of all involved). The difference from Appreciative Inquiry was not to propose that these were definitively 'best practice', but that they were floated as interesting cases which would provoke further study, enquiry and would perhaps stimulate experimentation with teaching strategy. I was at pains to explain that it was the learning that was the principal focus and not the teaching since there are many influences on learning which need to be considered.

Possible Links with Complexity Theory

The above approach appeared to have a Complexity Theory feel to it since if Learning Episodes were published, on the web for example, then there was the chance through feedback and adaptation for them to 'evolve'. In short they could constitute a Complex Adaptive System, in the terms of Complexity Theory¹³. Apart from casting the teachers (and pupils) as active participants in the process it had a formative basis which teachers could see would lead them to useful conclusions about their practice. Torrance and Prior [2001] point out that using formative assessment in the classroom is close to research activity. In this case formative assessment is promoted at several levels and would be facilitated by publication in hypertext format. Bolter [1991] explains that within hypertext media it is possible. 'for we as readers to follow those connections and move through space along predetermined paths of interpretation, or we forge our own paths, which we choose to leave behind for other readers.'

The collection of data to be analysed in some of the ways suggested above then became a major concern. Clearly the type of instruments used and the background assumptions inherent in these had to be compatible with Complexity Theory if they were to allow detection of features of this. As mentioned earlier, I could not find any examples of such instruments in the literature and therefore had to design these myself. The result of this quest was the Learning Episode.

The Background to Learning Episodes

The Learning Episode developed out of a desire to make learning the central focus. I wished to shift the main emphasis for teachers from what they do to what changes the pupils are undergoing since this, in the end, is what is important. Others have argued for the importance of making learning the central focus of

¹³ This is analogous to Dawkin's [1976] idea of 'memes' as evolving cultural units. I note also that Katherine Hayles (1999) has made the case for hypertext environments as Complex Adaptive Systems.

research attention. For example, Dimmock [1995] describes the approach as mapping backwards from:

- Student outcomes, to
- Learning styles and processes, to
- Teaching strategies, to
- School organisation and structure, to
- Leadership, resources, management, culture/climate

I move now to a description of Learning Episodes, the theoretical basis for their development and how I use them in practice.

Using Learning Episodes as a research tool

Biggs and Moore [1993], cited in Watkins et. al. [1996] [2001], have developed a model for school learning which provides a useful template for data collection. This model is shown in diagrammatic form in figure 5.1. It links:

- learner characteristics
- teaching characteristics
- teaching and learning processes
- outcomes

within a framework of:

- the classroom context
- the school and wider context

The task or learning objective is also important since it is difficult to make judgements about learning unless the 'destination' is envisaged. Learning objectives have been included in a later version of the model, (Hallam and Ireson, [1999]). The Biggs and Moore model below, highlights the dynamic nature of the learning process.

There are numerous models of learning in the literature and many are linked to modes of teaching (see Joyce et al, [1999]). The Biggs and Moore model shown

below was chosen because it displays the dynamic links between different elements related to learning. There may be problems with terms such as 'teaching characteristics', which suggest a set of properties physically related to the teacher herself. Considering the position of the learner and teacher may prove more fruitful, based on multiple, subjective viewpoints. For that reason I have deleted the word 'characteristics'.

DIAGRAM REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES



Fig 5.1 A model for school learning (source: Biggs and Moore [1993])

When introducing the collection of Learning Episode material to teachers I have stressed that I am primarily interested in examples of pupil learning. Clearly the teacher is important, but I am not attempting to judge their performance. Nor am I trying to give a balanced view of the lesson. I explain that I will try to relate the learning that I think is happening to the range of factors shown in figure 5.1. During and after the lesson I will discuss the importance of what I am observing with the teacher, and with pupils. The Learning Episode form becomes a set of working

hypotheses about what is important in promoting pupil learning. The reaction of teachers to date has been very positive and appear to stimulate reflection on learning. This could represent an example of double-loop learning [Reed and Stoll, 2000] or meta-learning [Watkins et al 2001], where the underlying processes are explored. Double-loop learning is not an automatic consequence of reflecting on learning. As Argyris [1999] shows, double-loop learning only occurs when the variables governing actions are examined. These are often held by actors as theories-in-use and are not necessarily in the actor's conscious realm. This highlights the importance of an external agent (in this case an education adviser) to assist in the process of change. Teachers commonly share lesson ideas and plans. Judgements about the worth of these are made by teachers on the basis of often tacit understandings about 'what works'. The Learning Episodes approach developed here aims to provide a vehicle for establishing more explicit knowledge based ultimately on gains in learning.

On the face of it this appears to be a useful professional development approach but would not normally be classified as research. This is where the 'evolutionary' perspective of Complexity Theory becomes important. My strategy was to document as many Learning Episodes as possible and use these as a basis for discussion with the class teachers involved and with other teachers. I emphasised that these are models relating some aspects of learning and not attempting to represent the full reality of a situation and that the validity and/or usefulness of such models would depend on two factors:

- To what extent common features can be identified across a number of Learning Episodes?
- To what extent the ideas contained in a Learning Episode prove useful in increasing the effectiveness of learning over time?

As previously described, I reasoned that those Learning Episodes which prove to be durable and effective will thrive and gain more prominence and those which are

less effective will decline in their influence. Learning Episodes would not be judged or graded initially. I am hoping that, over time, I will be able to track a refinement and increasing sophistication in the language and understanding of the learning. The early Learning Episode forms are couched in predictable jargon, which may strongly reflect my own background as a teacher and adviser. It was intended to publish the Learning Episodes on a website. The internet may become a medium within which Learning Episodes can compete. Teachers will hopefully select and adapt Learning Episodes for their own use, these adaptations becoming new Learning Episodes. I have also started to fill in Learning Episode forms when working with a group of teachers on a discussion of their individual forms. It would be possible to use the same forms with pupils. The advantages are that learning is viewed and recorded at each level using the same techniques. Learning episodes and their analysis portrayed above meet many of the criteria for Qualitative Comparative Analysis outlined by Byrne [2001]. It is unlikely that this present project will collect enough examples of learning episodes over time and engage enough colleagues in their use to reach a definitive conclusion about their usefulness. I did, however, have expectations about the use to which Learning Episodes could be put over time and these longer-term plans for Learning Episodes are described below.

The Future of Learning Episodes

A major concern will be to find ways in which teachers can easily record the main features of a Learning Episode and access the full database. Some teachers may find the double-loop nature of this approach rather esoteric which suggests the importance of personal contact to show the relevance of collecting this information. I will need to experiment with different headline pages linked to the Learning Episode data form, which attract teachers to locate and explore ideas for learning. Meta-learning about different approaches with teachers can also be documented using the same basic Learning Episode format which may initiate a staff development level of Episodes.

A longer-term project will be to explore the use of the information collected and the links formed within the information network. There will be important implications for professional development of teachers and advisers if an interactive database of information is available on learning and context. This will be part of a project to identify the contribution of the work of advisers in school improvement. Should this approach prove to be effective then support and management structures may also reorganise to support the emergent understanding and to support future enquiry based on this grounded approach. Opening up learning in this way encourages reflection on organisational and management issues. For example, the role of the Headteacher in the junior school GL can be contrasted with that in another school where the enquiry method has a different status. I suggest that using Learning Episodes in this way has the potential for developing educational 'Learning Organisations' to use the terminology of Senge [1999] and Leithwood et. al. [1998] where individuals and the organisation focus on the process of learning and on developing the capability to learn. This longer-term plan is beyond the immediate scope of the thesis, the more immediate development and use of Learning Episodes and associated interview material and their analysis is described in Chapters 6 and 8.

An Approach to the Analysis of Qualitative Data

The 'evolution' and emergence of successful learning episodes within an electronic medium will clearly take some time. As mentioned in the introduction, I was concerned that the early Learning Episodes, written largely by myself, were not sufficiently 'evolved' to support detailed analysis. I therefore decided to explore complementary data analysis techniques which could be utilized within the time-span of this thesis, while still experimenting with the process described above. This analysis centred on the interviews which accompanied the Learning Episodes and is fully described in chapter 8.

The Learning Episodes were filled in by myself and amended in discussion with the teachers concerned. I was aware that the notes on the Learning Episodes in this

initial stage were heavily biased towards my own perspective. In order to allow the voices of the school learners to be represented I undertook a more structured discussion with some of the key participants. One lesson in each of GL and LL schools was videoed which provided a valuable resource for further reflection on the lesson. Ten teachers in each of schools GL and LL agreed to have post-lesson discussions recorded and six in MA. In all three schools groups of pupils were interviewed about their perceptions of what helped them to learn. In GL, the Headteacher, Deputy Headteacher and one further teacher were interviewed at length. These interviews were open-ended and centred around a discussion of the learning episode. The main question asked was, 'What learning do you think was taking place and what aided and hindered this?'. I moved on to more general questions about who and what helps learning and, in particular, what do other people say and do? I intentionally did not define learning since I wished the respondent to choose their own definition either explicitly or implicitly. This pattern was repeated with a senior manager and teacher in school LL and with two teachers in school MA. Advisory colleagues who work with all three schools were interviewed. Again the selection of staff for interview depended on interest and availability rather than any pre-arranged sampling plan. All interviews were transcribed for use in the qualitative analysis phase of the project.

When considering how to analyse the interview material, I was influenced by Brown and Dowling [1998] who point out that the method of data collection should be consistent with the theoretical framework in which one is working. They also highlight the difficulty of moving between the theoretical and empirical. This appeared to me to be one of my major concerns, how complexity ideas could be operationalized in education settings. I made a decision at this point to pursue two lines of inquiry. First, the use of quantitative data that might be available and to apply some of the Byrne techniques discussed above and second, to develop some form of grounded approach. It appeared to me that a dialogic process involving Complexity Theory and data collected from the educational settings might hold the best chance of seeing the emergence of an appropriate conceptual frame.

It appeared consistent with Brown and Dowling's advice to be using such a strategy to study emergence. Foremost among influences on the handling of qualitative data in a grounded way was Social Activity Theory.

Paul Dowling's [2001] Social Activity Theory provides a protocol for the analysis of social action. He argues that sociology is concerned with patterns of relations between positions which are characterised as either alliances or oppositions. Alliances and oppositions are established, maintained or destabilised in social action. The visible forms of social action are cultural practices. The strongly institutionalised forms of these he calls activities and weakly institutionalised, strategies [Dowling, 1998]. Activities and strategies recruit cultural practices as resources in the establishment, maintenance and destabilisation of alliances and oppositions. Activity which contributes to the repertoire of practice can be understood as competence, whereas strategies which contribute in the same way can be understood as performance. Activity regulates who can say or do what.

The subject, in Dowling's protocol, is placed at the centre of the analysis and is always the author of action. Authorship implies an audience and a content or practice. There are two modes of relation in Social Activity Theory; Pedagogic, where authority rests with the author and Exchange, where authority is with the audience. Dowling describes levels of distribution of authority between author and audience in each mode as follows:

Pedagogic Mode:

- Apprenticeship – at least part of the audience constructed as potential author
- Dependency – audience has limited access to authorship
- Objectification – audience has no access to authorship

Exchange Mode:

- Innovation – maximal authority distributed to author

- Routine – some authority distributed to author
- Compliance- no authority distributed to author

The nature of a discourse is determined by: i) The extent to which the principles of evaluation are negotiable; and ii) the manner in which the principles of evaluation are enacted. The principles of evaluation refer to the those principles, either explicit or implicit, which apply to production of the discourse. Modes of action can be specialised or generalised. This refers to whether or not the mode of action indicates specific examples of its descriptive artifice on the one hand or detaches from such specificities so as to extend its power on the other. The power of the apparatus is either delimited or extended by modes of action.

Dowling calls the process of analysing social situations in this way 'Constructive Description' and emphasises that it is a learning theory since the apparatus and empirical site can be understood as an equilibrating system. The theory may also become its own empirical site.

As a practical programme, Dowling suggests starting with each subject in turn and mapping out how they populate the space in terms of positions and practices (what is said and done). Categories should then be developed from the utterances of subjects. Comparing and contrasting categories across subjects and schools then allows the development of topographies within which continuities and discontinuities can be observed. In the case of educational research, structured analyses of each school could then be developed.

The practical programme suggested by Social Activity Theory appeared to offer an opportunity to analyse levels in a way conducive to the exploration of Complexity. Dowling highlights the 'fractal' nature of relationships, where there may be similarities between levels, but where discontinuities are important. I considered that Complexity Theory might suggest a third category apart from opposition and alliance. Complex Adaptive Systems often exhibit a co-evolutionary mode where

parts of the system interact in a way which promotes the best interests of the whole but where the parts are in dynamic interrelationship. This might be explored once the analysis was under way. Social Activity Theory relies on 'constructive description' which is a dialogic process involving theoretical and empirical fields. The feedback and reflective aspects of SAT complement ideas within Complexity Theory, as does the 'fractal' nature of the protocol. The practical programme outlined by Dowling is clearly compatible with the Complexity Theory idea that it is important to focus on local situations and operate simple, local rules, observing the patterns that emerge.

The practical question was how to interrogate the Interview material dialogically, as suggested by Brown and Dowling [1998]. Social Activity Theory appeared to offer guidance on this question. Brown and Dowling claim that,

'activity is the contextualizing basis for all social practice. An activity like teaching establishes a range of positions, which can be occupied by human individuals. The activity also constitutes a range of practices which are distributed to these positions.' Brown and Dowling [1998 ,p164].

In order to activate the SAT approach I decided to take each of the subject levels in turn: pupil, teacher, senior manager and adviser and explored how each views learning at all of positions at the other levels. This program is designed to explore the positions and the practices, which are revealed by the material I have collected. It should be emphasised that much of this material comprises descriptions from the researchers vantage point and as such may provide a window onto these positions and practices, but which is mediated by the researcher's views. Using Dowling's approach these positions and practices are scrutinised to assess their level of negotiability and how they are enacted. They are also considered as being either generalised or specialised. The final part of this section explores the development of Learning Episodes in more detail since this was the starting point for my fieldwork. When examining these positions and practices I utilized Nvivo, a qualitative analysis software package. I hoped that this would allow me to generate

theoretical apparatus, as Dowling [2001] suggests, out of dialogue between the theoretical and the empirical. He likens the exploration of new settings to a form of equilibration (following Piaget) and explains that the resultant theory is to be seen essentially as a mode of working. Dowling has developed categories within Social Activity Theory, which I could utilize to explore positions and practices at different levels within schools.

As can be seen from the discussion above the process of establishing appropriate methodology for this thesis was difficult. I expected that this would be a major issue since there are few pointers to the 'operationalising' of Complexity Theory. The following chapters 6, 7 and 8 describe the analysis of quantitative and qualitative data in ways influenced by the discussions above and describe the emergent outcomes from this analysis.

Chapter 6 The Initial Use of Learning Episodes and Interview Data

In this chapter I describe the three schools within which most of the work was undertaken for this thesis. I then summarise my initial use of the Learning Episodes and interview data showing how this supported teacher professional development and prepared the ground for more intensive analysis in chapters 7 and 8.

The Choice of Schools for this Thesis

The criteria for selection of schools for the study were relatively simple. I decided that collecting data from no more than three schools was manageable in the time available. The first was chosen because all the indicators are that its pupils make good progress and because I know the school well (being the School Development Adviser). The second was a school with a similar intake to the first but with rather a different management structure and 'feel'. I hoped that this would provide some interesting comparisons. The third school serves a very different catchment area from the other two, thus providing another set of comparisons. There was a certain degree of arbitrariness to the decisions about which schools to work with since the aim was to explore emergent properties and not to conduct a systematic enquiry. This thesis aimed to explore possible data collection techniques and analyses rather than arrive at generalizations about Torfaen schools.

Within each school the aim was to work on Learning Episodes with as many staff as possible. In all three schools staff meetings were addressed explaining the nature of the work and asking for volunteers. Observations, interviews and the collection of Learning Episode material was then followed up with willing teachers in the first instance. As can be seen in Chapter 7 which describes the quantitative data analysis, pupil scores in the core subjects at Key Stages 1 and 2 are available for several years and the individual pupil level scores in two schools. The majority of my focus was on progress and learning in mathematics, since my subject focus in the Authority is mathematics. However, results in English were used as a comparison and some of the lessons observed involved subjects other than mathematics.

School Contexts.

School GL

This is a junior school serving pupils aged 7 to 11 years and is situated in a village to the south of Pontypool. The school grounds are spacious with extensive playing fields. The main building houses ten classrooms, technology centre, IT suite, special needs teaching area. There are around 340 pupils on roll taught in 12 single-aged classes. Pupils are drawn from the traditional catchment area as well as from further afield, due to parental choice. Pupils are drawn from residential areas that are neither prosperous nor economically disadvantaged. Around 8% are registered as being entitled to free school meals, which is well below the local and national averages. The intake of pupils covers the full range of ability. Around 12% of pupils are identified as requiring special educational needs (SEN) support, of which three have statements of SEN; again this is below the local and national averages. Around 1% of pupils come from ethnic minority backgrounds and 4 pupils receive support for speaking English as an additional language. No pupils are natural Welsh speakers. The Headteacher has been in post for a number of years and has appointed most of the teachers now in post. The majority of teachers at the school have taught for less than 10 years.

School LL

LL is an all through primary school with around 350 pupils on roll situated in a relatively prosperous area of Cwmbran. Around 8% of the pupils on roll are eligible for free school meals. The headteacher has been in post for a number of years. English is the predominant language for most pupils. Two percent of pupils come from ethnic minorities. The teaching staff are a mix of more experienced and newly qualified colleagues.

School MA

This Primary School and Infant Assessment Unit is situated in the heart of the town of Cwmbran. Three-quarters of the 350 pupils on roll are reported to be drawn from backgrounds described as economically disadvantaged. Twenty seven percent of pupils are entitled to receive free school meals and a similar percentage have participated in pre-school education. No pupil speaks Welsh as a first language. The Infant Assessment Unit which is part of the school, provides for 25 pupils ranging from 5 to 7 years of age. Additionally, in the mainstream school, 7 pupils have statements of special educational need. The headteacher during the time of this study had been in post for a number of years. He has since left for another headship elsewhere. The majority of teachers at the school have taught for less than ten years.

When attainment in English and mathematics was compared, the intake of schools LL and GL was quite similar. Those pupils who entered Key Stage 2 in September 1998 were tracked by the schools until their National Assessment Tasks in May 2002, the culmination of their primary career in Year 6. Two tables below show how similar the attainment of these cohorts were on entry to Key Stage 2. This information has particular significance when linked to the final grades of the same pupils in 2002 which gives a measure of the progress made by individuals in each school.

Table 6.1 A comparison between attainment at intake of pupils in schools LL and GL (intake Sept 1998)

School LL

50 pupils were matched between Key Stage 1 and 2.

Table showing number of pupils starting Key Stage 2 by level and gender

Number of pupils at this level, start of Key Stage 2	Gender	English	Maths
Level 1	f	2	2
	m	4	3
Level 2	f	21	19
	m	23	21
Level 3	f	0	2
	m	0	3

School GL

66 pupils were matched between Key Stage 1 and 2.

Table showing number of pupils starting Key Stage 2 by level and gender

Number of pupils at this level, start of Key Stage 2	Gender	English	Maths
Level 1	f	3	3
	m	7	3
Level 2	f	26	23
	m	22	20
Level 3	f	6	9
	m	2	8

The Initial use of Learning Episodes and Interview data

A large proportion of the data collected for this study was in the form of Learning Episodes. The background to these has been explained in the chapter on methodology. Around forty Learning Episodes were collected in the three study schools and many more elsewhere. Most of these resulted from observations in class by myself. Some were written by teachers as summaries of their own observations in class. In each of the three schools I have led discussions with individual staff and with school staff as a whole based on the Learning Episode forms. In a few cases I have conducted interviews with the teacher and pupils involved, and in two cases obtained a video record of the lesson.

The original plan for this data was two-fold. First, to provide opportunities for teachers to reflect on the links between the context, including their own actions and the learning outcomes. This was to be accomplished through guided discussion soon after a lesson or series of lessons and also through the accumulation of Learning Episodes within the Authority which would be available for teachers to refer to, to adapt and amend and as a source of ideas for their further work. The second aim was to provide data which could be explored to establish common themes.

A number of possibilities presented themselves when considering the analysis of this data in the form of Learning Episodes. In the following sections I provide examples of the approaches I investigated which show some of the information which can be extracted and the use to which this can be put with teachers and in an attempt to understand the complexity of learning in school.

I start below with a single Learning Episode, describing how I discussed this with the teacher, exploring the links between the notes compiled under each heading. This example is then extended to include discussion with the whole staff based on

a number of Learning Episodes written in their school. Finally, in this section I describe some plans for extending the use of Learning Episodes across schools.

Investigating complete Learning Episodes and groups of Learning Episodes in one school.

As described previously, the Learning Episode forms contain the following headings:

- **The learning tasks**
- **The learners'** prior knowledge and readiness to learn
- Aspects of the preferred **teaching** style and approach
- **The teaching and learning process**
- **Learning outcomes**

The following example records a lesson observed in school GL. The boxed sections contain the notes that I made during my observations and amended / enhanced by discussion with the teacher afterwards.

Part a) of the learning tasks were prominently displayed as a WIL statement (What I Learn). As explained in the Teaching and learning processes section below, the teacher provides this at the beginning of a lesson or series of lessons. WIL takes on the form of a character. His statement is to be answered by NIKI (now I know it) by the pupils at the end of the lesson. Through NIKI, the pupils show how they have achieved the learning tasks and reflect on difficulties on the way. This routine is well established in this classroom in most lessons and is being adopted by most other teachers in the school.

Learning Tasks:

- a) To discover that the circumference of a circle is approximately 3 times the length of the diameter and to use this information to find either diameter or circumference given the other. b) To enhance pupil self-reflection

The teacher shared the learning objectives with his pupils and introduced the activity as I describe below. At the end of the activity the pupils gave their account of what they had learnt and how the lesson went.

Teaching/Learning processes

Pupils were given a WIL statement (What I Learn) 'That I can work out the circumference of a circle if I know the diameter'. They measured the circumference and diameter of a number of circular objects and record these measurements, looking for a pattern in the results. The teacher nudged them towards seeing the 3:1 ratio in results. The practical approach appeared crucial to the understanding and memorability of the concepts involved. Near the end of the activity, pupils wrote a NIKI statement (now I know it) explaining what they knew and how they could show it, plus issues of what was easy to understand and what was not. The discussion of what is learnt and how is a general feature of plenaries in this classroom. The next WIL statement asked for greater accuracy by using the formula including pi. This was negotiated with the pupils.

I was particularly interested in how the task and the way it was set up enabled the learning. This was discussed in some detail after the lesson using my notes as a starting point.

Outcomes

Pupils associated the circle facts with the activity they had undertaken. Most had a 'feel' for this result which was supported by their use of practical measurement. The WIL and NIKI statements again made practical sense by their association with two individuals (a Wil and a Niki). This reinforced the importance of feedback for learning, from others and from oneself.

Discussion about the WIL statement and suggestions about how we will know if it is achieved lead the pupils to greater awareness of the learning process.

Successive and refined WIL statements allowed the pupils to track progress in their learning and model the importance of feedback and the development of understanding.

I also attempted to link the outcomes to what the learners and the teacher brought to the classroom.

Learners

Mixed-ability Y6 class, after National Curriculum Assessments in the summer term, who clearly enjoy this problem-solving and practical approach. They respond readily to the task and to the idea of evaluating their own understanding.

These pupils have been working in this way for over a year and appeared to be comfortable with the idea of reflecting on their work in this way.

Teacher

The teacher was keen to build the pupils' capacity for learning, he believed that this is as important as the content and also that practical work improves understanding as does the forging of links across subjects and between areas of the same subject. The teacher enjoyed variety and novelty in teaching and learning.

The teacher modelled the evaluative and self-reflective process which he was trying to encourage the pupils to undertake. In discussion after the lesson he explained how the WIL and NIKI approach had been talked through with his pupils. He believed that they were clear about the reasons for using it. We discussed the value of pupil reflection on learning, in particular the value of pupils negotiating their next task, and the use of a practical approach. The Learning Episode notes did no more in this case than reinforce the teacher's convictions that pupils made good progress in the lesson. The teacher observed that this way of working might not be successful in all classes and in all schools.

This Learning Episode, along with several others, was shared with the staff at a meeting. These stimulated discussion about what is working well within the school. The value of collecting such examples became more apparent at this stage. Some of the less convinced teachers, when reading and discussing the Learning Episodes, could see the value of the WIL and NIKI approach and became resolved to continue using it. They could also see the value of more open-ended and practical activities in mathematics for promoting conceptual understanding. There was debate about the time available for such activities given the content to be covered. Having some documented evidence of learning associated with this approach reassured the more sceptical colleagues. The teachers engaged in speculation about how the elements of the lesson and the context worked together to promote successful learning. A large part of the success of these discussions stemmed from the fact that staff were focussing on what was working well. This encouraged them to reveal their own anecdotes. What was missing in this case,

however, was the voice of the pupils, apart from comments made to me during the lesson itself.

Discussions resulted in staff agreeing to try collecting their own examples, either by observing each other or by making some personal notes. I explained that these notes could be short and relate to just one aspect of learning within the class. The notes would serve to provide some brief reminders so that teachers could piece together the factors which influence learning. An external 'critical friend', in this case the School Development Adviser, was very important in the early stages in particular, documenting, summarising and facilitating the discussion. This way of working proved to be popular with staff. When a number of such lesson observations were undertaken, staff felt comfortable about sharing the findings and lively debates were often launched during which other teachers related observations from their own classes. Staff and pupils showed a willingness to reflect on their work. It is not uncommon for teachers working with or without advisers to reflect on the efficacy of teaching styles and strategies. What is unusual, however, to try linking a range of dynamic features to learning outcomes.

The technique appeared to become even more powerful when linked to other interview material from the pupils and the teachers involved in the lesson. In a further case, I videoed the lesson and interviewed the teacher and six of her pupils afterwards. The teacher subsequently viewed the lesson and discussed it further with colleagues. The success of the use of observational and interview data convinced me that interviews, along with the collection of Learning Episodes, should be carried out in all three schools.

Implications of the initial use of Learning Episodes and Interview data.

Learning Episodes appeared to capture something of the dynamics of learning and the influences upon it. The discussions which ensued with individual teachers and with whole staffs were extremely rich and generated a number of new ideas which

teachers then wanted to try out. I have used the approach in a number of schools now and the positive emphasis, along with the focus on learning, is popular with teachers. There are, however, drawbacks to the approach. It is time-consuming and it appeared that Learning Episodes were of little interest to teachers in other schools. Attempts to share them across schools have not been successful at this stage. This is not perhaps surprising since the personalities behind the lessons and learning activities are important and the Learning Episode notes themselves are rather dense. Where discussion around the learning Episodes has stimulated development of practice it has been 'guided' or 'chaired' by the researcher or an enthusiastic coordinator in the school. It appears that it is necessary to have such guidance at least at the beginning of the process since teachers are not used to and sometimes reluctant to discuss their practice openly. Given the positive emphasis of the Learning Episode notes, teachers soon overcame this initial reluctance. In the case of all three schools in this study, teachers claimed to find the experience non-threatening and useful, in contrast to their experiences of external inspection.

On the basis of a limited trial, I decided that the plan to circulate Learning Episodes around schools was unlikely to work at this stage. Teachers understandably feel unable to commit time to the reading of detailed notes. Teachers are generally interested in 'good practical teaching ideas'. With this in mind, I designed a set of short and succinct references to teaching ideas which I hoped would attract practitioners' attention and which might entice them to follow up and look at a full Learning Episode. The 'Torfaen Teaching Tips' as they are called are not expected, in themselves to change practice. I hoped they might, however, start a chain of events which would eventually lead to improved pupil learning. Each idea fits on one A5 page, it includes a picture of practice in Torfaen, a short description of the idea and links to a teacher using it. There are also links to a fuller description of the lesson including the Learning Episode notes which I hope will then be followed up. The teacher links include an e-mail address and phone number to allow direct and immediate contact with a person practicing the suggested idea.

The idea, inspired by Complexity Theory of positively motivated observations of teaching and learning being 'floated' on the internet and treated as a Complex Adaptive System, may eventually be realised. This will not happen in the time taken to produce this thesis. Formats for future Learning Episodes will continue to be trialled past the completion of this thesis. I reasoned the material collected, however, would provide an opportunity for me to refine my own practice of working with teachers using the Learning Episode material along with interview data. In chapter 8 I explore these possibilities. In chapter 7 I describe the analysis of quantitative data which ran in parallel with the use of Learning Episodes and interviews in the three schools.

Chapter 7 Analysis of Performance Data.

This chapter summarises the analysis of available quantitative data from the three schools in the study which ran in parallel with the Learning Episode and Interview material. I was keen to avoid what I perceived to be the shortcomings of classical statistical approaches to quantitative analysis. Although there are no official league tables in Wales, the achievement of satisfactory levels of pupil performance on the National Curriculum tests, and the steady improvement of these scores over time, are regarded as important indicators of success by schools, parents and LEAs. Such measures figure strongly in SESI literature. I decided that pupil performance data should be included in my own study, but that I would concentrate on experimenting with analyses of the data which appeared to be compatible with Complexity Theory. The majority of SESI projects utilize qualitative and quantitative data. I wished to explore some possible Complexity Theory inspired approaches to the use of performance data and also to consider how such data might complement my use of interview and observational material. This analysis is not aimed at making definitive judgments about schools but is designed to raise questions and stimulate discussion. As the discussion at the end of this chapter suggests, the outcomes are highly tentative, since the techniques are at an early stage of development.

Criticisms of reductionist approaches to the study of schools have been discussed in an earlier chapter. These considerations have influenced the analyses of data that I undertook. In this section, I first describe my approach to using performance data. I then show how these have added to my understanding of the schools in the study through examples of 3 different approaches. The performance data analyses will later be linked to the class and school perceptions of learning undertaken through interview and observation.

Principal Considerations in making decisions about the use of data

There is acknowledgement among researchers and most school-based personnel that raw pupil test scores do not by themselves give an accurate picture of school effectiveness. Clearly a 'fairer' measure of effectiveness would be based on the progress made by pupils while at the school from whatever starting point. The extent of the school's influence on pupil progress may vary according to contextual factors such as socio-economic background of the pupils and the socio-economic mix within the school. In the event, I decided that, where possible, I would collect data at individual pupil level and data which reflected pupil progress. Schools and LEAs tend to use data which is readily to hand. This is, I believe, quite understandable. Most of the performance data I have used in this study falls into this category. In assessing the usefulness of such data I will also be beginning to build an argument for the collection of further forms of data.

The accessibility of data often reflects the importance placed on the issues involved. Performance data in Torfaen is split by gender, which corresponds to the present almost universal concern about the 'underachievement of boys'. I used gender in my analysis as examples of an important discriminatory variable. I argue that if the techniques prove valuable then it might, in future, be worth while investing time on obtaining details about socio-economic class, for example. It is suggested by some researchers (Sammons [1999]) that performance disparity between pupils from different socio-economic backgrounds is several times greater than the gender disparity. Data on ethnicity may also prove to be important, although ethnic minority groupings within Torfaen are small at present. Another variable already available is pupil age. Age of pupils is related to attainment and I explore some methods of incorporating age into the analysis later in this chapter.

Since I had access to whole-school data and some individual pupil data, I decided to use both. I wished, however, to avoid techniques from classical statistics. There are a number of reasons for this. First, the cohort sizes are small and conclusions

drawn using classical statistics may have little statistical significance. Perhaps more important, in my judgement, was the fact that classical techniques tend to 'smooth out' irregularities, which are just what might prove interesting from a Complexity Theory perspective. Techniques drawn from Exploratory Data Analysis (for example Marsh [1982]) and developed by Byrne [2002] suggested more fruitful approaches.

I decided to concentrate on test data in Key Stage 2 and where possible in Key Stage 1 when analysing quantitative data. This was because of issues about moderation of teacher assessment across schools. There are, of course, numerous concerns about test scores. For example, there are concerns about the relationship between test scores and understanding and whether some schools expend more effort than others on 'getting pupils through the tests'. At whole-school level there are issues about the stability of cohorts and pupil mobility. When considering pupil progress there are issues about the consistency of tests across years and Key Stages and the breadth of the national Curriculum levels used to report pupil scores. I attempted to overcome some of these issues in the following ways, by splitting National Curriculum level analysis at key Stage 1 and by focusing on Mathematics and English scores and, where possible, by utilizing a comparison between scores on the two subjects for the same pupil. My rationale for this second strategy is that, although no direct linking of levels across subjects is undertaken it is significant if, for example most boys in one school score higher marks in maths and lower in English whereas for girls the reverse is true. This strategy is outlined in more detail below . Three methods of data analysis are now described. These are:

- **Approach 1:** Comparing results by gender and English/mathematics for a given year.
- **Approach 2:** Using individual pupil-level results to gauge levels of progress and make inter-school comparisons.

- **Approach 3:** Cluster analysis using three variables; attainment, comparison between subject marks and age at Key Stage 2.

In each section I discuss what the analysis shows. A summary section synthesises the findings and discusses the connections between these techniques and Complexity Theory.

Approach 1) Comparing results by gender and English/mathematics for a given year, and extension to look at trends across years.

This section involves the use of data at whole school level. The method of comparison used here looks at the mathematics and English results of a cohort of pupils in a school, in a particular year (I am not aware of this comparison being used elsewhere. I trialled the method in Cunningham [2000]). This method allows a comparison of how groups of pupils achieve on the same tests and when the teacher has been the same person for all (although in some cases groups may be streamed for part of the course). The percentage of pupils achieving a particular level (usually the expected level at that Key Stage) is shown in a table. Of particular interest is the relative performance of a group of pupils in the two subjects. By looking at relative performance, no judgements are made about progress since prior attainment is not taken into account. An explanation of the approach is given followed by details of the analysis at Key Stages 1 and 2.

**Comparing results by gender and English/mathematics for a given year.
(notes on method)**

This method of comparison looks at the mathematics and English results of a cohort of pupils in a school, in a particular year. The original intention was to make comparisons between the results of boys and girls, but any subdivisions of the cohort could be handled in this way. The approach may help shed some light on which sets of factors promote the achievement of groups of pupils. An example of

the type of initial analysis possible is given below. Figures show the percentage of boys/girls in the cohort achieving an expected grade for their year group.

Table 7.1 Example of gender/subject comparisons of performance data at whole-school level.

Type A

	Boys	Girls
Maths	75	75
English	50	80

Type A

Boys appear to underachieve in English

Type B

	Boys	Girls
Maths	75	50
English	50	80

Type B

Boys appear to underachieve in English and girls in mathematics

An example of the type of analysis that this can support is shown below .

Table 7.2 Comparison of Key Stage 2 results, (Percentage of pupils achieving Level 4+), in school GL 1998 to 2002 (by gender and by Maths/English)

GL (n approx 80)

	1998		1999		2000		2001		2002	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Maths	73	77	93	88	81	88	80	95	92	96
English	77	92	90	92	92	97	77	93	92	100

From this display of the results I made the following tentative judgements about the achievement of Boys and Girls compared across subjects, gender and across years:

1998: Girls appear to be achieving more highly in English

1999: Girls and Boys achieve similar results in both subjects

2000: Boys' maths results are lower and Girls' higher in English

2001: Girls appear to be achieving more highly in maths and English

2002: Girls and Boys show higher achievement in maths and English.

Clearly care has to be taken making comparisons between Boys and Girls and across years since prior attainment is not included in this case. I then compiled a tentative overall trend summary for school GL (this should be read alongside the yearly variations described above):

Girls are doing well in English and improving in maths.

This procedure was undertaken for all the available data in Key Stage 1 and 2. The trend summaries are shown below.

Approach 1 Overall Summaries from the analysis.

Although the overall trend summaries are reported here the variations between years are equally important from a Complexity Theory perspective. This has not been followed up in this thesis since it would be most valuable to link the variations to Learning Episode data at different points in time to enhance understanding of effective learning and teaching. In this thesis Learning Episodes were compiled at one time only.

1a) Key Stage 1 comparisons for 5 years from 1998 to 2002

The striking feature of this work has been how little consistency there is across the years. Given that teaching staffs in Torfaen remain relatively stable and often teaching the same year groups it is perhaps surprising that there is so little consistency in the observed patterns. These are, of course, different cohorts of pupils, however by tracking relative performance in subjects the absolute performance is not being compared. It should be noted that there is no official moderation of levels of difficulty between the English and Mathematics tests and these may vary year by year. There appear to be some trends across year groups, these are noted below. Note that the analysis is split into all level 2 comparisons and level 2b+ comparisons. This is because level 2b and above is regarded as a secure level 2.

Table 7.3 Summary of Key Stage 1 comparisons for the three schools for 5 years from 1998 to 2002

Table 1 All level 2 results were taken into account and compared with LEA as a whole.

SCHOOL	SUMMARY
NI (feeder for GL)	Boys underachieve in reading and writing, girls achieve well in maths and English.
LL	Boys underachieve in reading and writing.
MA	Boys underachieve in reading, girls achieve well in English and maths.
Torfaen LEA	Underachievement of boys in reading and writing, girls have improved in maths and are doing well overall.

Table 2 Level 2b and above taken into account and compared with LEA as a whole

SCHOOL	SUMMARY
NI(feeder for GL)	Big improvement in maths scores generally, Boys underachieve in writing.
LL	Big improvement in maths for boys and girls. Boys underachieve in writing.
MA	Big improvement in maths for boys and girls. Boys underachieve in writing.
Torfaen LEA	Big improvement in maths for both boys and girls

Discussion:

Across the 3 schools (including the feeder for the junior school GL), boys underachieve in reading and writing, as do girls in writing. There has been a big improvement in both boys' and girls' mathematics. Writing is much lower for boys and girls than either reading or mathematics. This only shows up when looking at level 2b and above.

Table 7.4 Summary of Key Stage 2 comparisons for the three schools for 5 years from 1998 to 2002

1b) Key Stage 2 comparisons 1998 to 2002

SCHOOL	SUMMARY
GL	Girls are doing well in English and improving in maths. Boys may be reaching similarly high levels.
LL	Girls are underachieving in maths
MA	Girls underachieve in maths.
Torfaen LEA	Girls do well in English and better than boys overall, there is a steady improvement boys and girls in maths and English.

Discussion:

For the three study schools; GL, girls do well in English and are improving in maths. Girls are doing less well in maths in LL and in MA Girls and boys scored very well in 2001 in maths and English in MA but this year was unusual.

Approach 2 Using individual pupil-level results to Gauge levels of Progress and Compare this between schools.

In this section, individual pupil-level results were used. 1998 was the first year of relatively stable National Curriculum test results after teething troubles had been sorted out. For two schools it was possible to match pupils across the Key stages (around 80% of pupils were matched in each case). The progress made by pupils in terms of improvements in levels in maths and English from 1998 to 2002 was investigated.

Comparison of Key Stage 1 results in 1998 were made with Key Stage 2 results in 2002 for the same cohorts. (This could not be done for 1997 to 2001 results)

Table 7.5 Percentage of pupils making level gains from Key Stage 1 in 1998 to Key Stage 2 in 2002 in two schools by subject and gender

School		LL		GL	
KS1-2		English	Maths	English	Maths
gains					
3+ levels	f	48	22	66	40
	m	44	26	84	39
2 levels	f	52	74	31	60
	m	52	74	16	59
1 level	f	0	4	3	0
	m	4	0	0	3

Discussion

This progress analysis proved to be very revealing. The two schools LL and GL had year 3 cohorts in 1998 with similar attainment profiles (see Chapter 6). As can be seen from the above table most pupils in both schools made at least 2 levels of progress during their junior years. The comparison between the number of pupils making three or more levels of progress is interesting. 84% of GL boys make three or more levels of progress in English and 66% of GL girls. A good proportion of both boys and girls make three or more levels of progress in maths. There is no necessary comparability between levels in English and mathematics so lower levels of progress in one may not reflect smaller learning gains. The across school subject comparisons, however, are significant and may suggest more effective learning by boys and girls (particularly boys) in English in school GL. The progress analysis described here confirms the overall Key Stage 2 trends in the last section, learning appears to be particularly effective in English in school GL. Underachievement in mathematics may be an issue for school LL. These rather striking conclusions were not reached by Estyn inspections in either school GL or LL. The reliance by the inspectors involved on final attainment means that they miss crucial clues to the effectiveness of learning.

The analysis in approach 1 is based on the attainment of level 4 by pupils (the expected level for this age group). Some pupils, however, attain level 5. I decided to make a comparison of the number of pupils achieving level 5 at Key Stage 4 by subject and by school for the years 2001 and 2002 to test my emerging judgement that school GL is successful in extending the learning of its more able pupils. As can be seen below, success at level 5 in GL was particularly marked in the year 2002 in both English and maths. This is also compared with the level 5 attainment in school MA and the LEA as a whole. The comparison of the levels of progress made must be of greater significance, however, since it could be argued that this is less dependent on attainment at entry. This may not be strictly true since a lower attainment on entry may allow more room for improvement. The large variation in

attainment in English between 2001 and 2002 for the whole LEA suggests inconsistencies in test standards (or a very large improvement in attainment in the subject).

Table 7.6 Comparison of pupils achieving level 5+ at key Stage 2 in 2001 and 2002 by school (percentage of pupils shown in each case)

School GL

	2001		2002	
	Boys	Girls	Boys	Girls
Maths	31	43	49	52
Eng	46	50	68	76

School LL

	2001		2002	
	Boys	Girls	Boys	Girls
Maths	56	32	33	30
Eng	31	36	30	44

School MA

	2001		2002	
	Boys	Girls	Boys	Girls
Maths	32	21	32	7
Eng	59	47	32	33

LEA

	2001		2002	
	Boys	Girls	Boys	Girls
Maths	23	26	28	25
Eng	21	32	33	42

I was concerned that although the initial attainment profiles of the two schools GL and LL might appear similar (see discussion in Chapter 6), there may be a number of reasons why pupils did not make similar progress. One of these reasons could be the maturity of the pupils. Younger pupils may not make the same progress as their older peers, for example. Another might be that lower levels of achievement in English might depress achievement in mathematics due to ability to read the script, for example. In order to explore these connections I introduced variables as described below in approach 3 and used the SPSS K-means cluster facility to explore whether variable aspects are found to occur together. To a large extent the variables used were those available to me and the activity was designed to explore the feasibility of the approach. Should it appear productive then further data could be collected around other variables and used in the future.

Approach 3 Cluster analysis using three variables; attainment, comparison between subject marks and age at Key Stage 2.

The set of pupil results were coded under the following variables which involved a measure of their overall attainment, relative attainment in maths and English and age of pupil compared with others in the cohort. Given in more detail these were :

Level to reflect whether attainment in mathematics and English was above average (1), average (2) or below average (3).

Compare to reflect whether maths was higher than English (1), English higher than maths (2), or both the same level (3).

Pupils' **age** was also clustered into three groups corresponding to three terms of their year of entry. Older third [Sept 89 to Dec 89] (1), middle third [Jan 90 to April 90] (2) and younger third [May 90 to Aug 90] (3).

Mode of operation

The complete file was first explored using 'descriptive statistics'. Frequency graphs and contingency tables allowed the relationships between levels of attainment in different subjects to be explored for different groups of pupils. The K-cluster facility was then employed (following Byrne [2002]) to explore clustering around the parameters 'level' and 'compare' as they are defined above. In using the K-cluster facility, the operator determines the number of clusters. After experimenting with different numbers of clusters from two to ten I settled on six which appeared to give a relatively even spread of responses while still allowing for some variation. The data set is relatively small and was printed out in order to allow visual comparison of the clusters. The composition of these clusters was then investigated by gender and school.

A Summary of the Clusters

When the K-means cluster number was set at 6 a reasonable distribution of clusters was achieved. There is, of course, no prior reason for setting any number of clusters apart from the fact that interesting groupings result. The six clusters were as follows:

Cluster 1 (17 boys, 23 girls)

English and mathematics results are the same and at the average level of 4

Cluster 2 (19 boys, 22 girls)

English mark is better than mathematics and attainment is above average

Cluster 3 (8 boys, 7 girls)

Mathematics mark is better than English and attainment is above average

Cluster 4 (5 boys, 7 girls)

English and mathematics marks are the same and below average.

Cluster 5 (5 boys and 2 girls)

Mathematics mark is better than English and attainment is below average

Cluster 6 (19 boys and 21 girls)

English and mathematics marks are the same and above average

In the future, these clusters could be investigated further to explore whether they represent consistent clustering in these and in other Torfaen schools and whether aspects from Learning Episode data can be associated with these clusters. Cluster 5, for example, where English attainment is below that of Mathematics and all attainment is below average would, I suggest, be recognisable to many teachers, and might be associated with some boys. A later piece of research might follow this up by exploring Teachers' and students' perceptions of these clusters. These clusters are not, however, necessarily representative of any stable patterns in the data, but when linked with the observations in approach 1, provide useful starting points for discussion.

Discussion

Given the above cautionary notes I have used the clusters as a basis for investigating trends in the data and these are shown below.

GL (12 out of 76 pupils achieved below level 4)

Younger pupils (both male and female) English and maths results about the same and at level 4

Middle age pupils, (which contained more females than males), English and maths results about the same and at level 4 or better.

Older pupils (both male and female) English results are better than maths.

LL (4 out of 38 pupils achieved below level 4)

Younger pupils (both male and female) English and maths at the same level at level 4

Middle age pupils were all female and achieved better results in English than mathematics at level 4 or better.

Older pupils were split between those for whom English results were lower than mathematics at level 4 or better, and those for whom English and maths were the same at level 4 or better.

MA (3 out of 41 achieved below level 4 in this year group)

Younger pupils, females achieved similar results in English and maths at level 4 and males achieved better English than maths at level 4 or better.

Middle age pupils (both male and female) English results were better than maths at level 4 or better.

Older pupils (both male and female) English and maths results were similar at level 4

One significant feature highlighted by this table is that older pupils appeared to do better at English than at mathematics, particularly in school GL. This might reflect the fact that older pupils in GL respond more positively to the responsibility accorded to them in their lessons. Their added maturity might enable them to gain more from the groupwork activities than their younger peers. This is, however, largely speculation. Age distribution of pupils across the three schools is relatively even. I would not expect, therefore that age in itself would explain why school GL pupils made more progress. The question of how pupils within different age bands were performing could be considered by further organisation of the data. A comparison could be made by taking the group of 155 pupils from the three study schools as a whole and splitting them by gender and by age band. This is shown below.

Table 7.7 Comparison of level of achievement with age band, split by gender (2001 cohort)

Age band	Above average		Average		Below average		TOTAL	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Older (Sept to Dec 1989)	14	20	6	6	2	2	22	28
Middle (Jan to April 1990)	15	18	2	4	4	8	21	30
Younger (May to July 1990)	13	6	10	14	7	4	30	24
TOTAL	42	44	18	24	13	14	73	82

As might be expected, it can be seen that many more older pupils achieved above average results than average or below and there appears to be an even spread of boys and girls in each achievement band. In the middle age band, twice as many pupils achieve above average than average or below and there are twice as many girls as boys in the average or below bands. Among the younger pupils, most are average or below by a factor of nearly 2 to 1. There are twice as many boys as girls in the youngest above average group. The number of pupils involved is small and care need to be exercised when considering the significance of these observations, but the exercise does raise interesting questions about the relationship between age and attainment. I hoped that further splitting the data by school might reveal interesting differences between them.

Splitting the pupil data by school, attainment levels and comparison of performance in maths/English

The resultant table below shows a similar ratio of higher attainers in GL and LL which contrasts with the picture in MA. In all three schools the greatest number of pupils achieve comparable results in English and mathematics.

Cross-tabs of level against compare split by school where level and compare are defined as:

Level to reflect whether attainment in mathematics and English was above average (1), average (2) or below average (3).

Compare to reflect whether maths was higher than English (1), English higher than maths (2), or both the same level (3).

Table 7.8 Comparison of overall English/maths attainment with differences between English and maths attainment. (percentage of pupils in each school)

School	Level	Compare			TOTAL
		1 m>e	2 e>m	3 e=m	
GL	1 above av	6	14	22	42
	2 av	1	1	17	19
	3 below av	6	3	6	15
	TOTAL	13	18	45	76
LL	1	7	4	9	20
	2	0	0	9	9
	3	0	5	4	9
	TOTAL	7	9	22	38
MA	1	2	13	9	24
	2	0	0	14	14
	3	1	0	2	3
	TOTAL	3	13	25	41

Significant in this display is that for more able pupils across all 3 schools attainment in English is equal to or better than attainment in mathematics. This is reflected in many of the clusters in the previous analysis. For many of the below average pupils, mathematics was their better mark.

Discussion of the Three Approaches

The analyses undertaken and reported above are exploratory and generally tentative as the individual discussions show. I suggest that there are a number of interesting possibilities arising from these analyses which could be followed up. Comparisons of pupil progress appear to suggest areas where further discussion and observation might prove fruitful. Comparisons across subject attainment for the same pupils provide an alternative method of handling whole-school data and could be extended to analysis at pupil level.

The variety of data displays employed here provide opportunities for exploring small-scale differences. These, in conjunction with qualitative data, may help to build a picture of the dynamic activity in the three schools which is in line with a Complexity Theory approach. This would be effective if combined with Learning Episode data and conducted over a period of time. The work undertaken here has been labour intensive, moving data from one application to another. This could be automated using macros and allowing control over a variety of groupings and levels. Comparisons across the 3 approaches can be made for the key Stage 2 2001 cohort for which data is available.

Approach 1

Variations year on year show very few consistent trends which might be considered surprising since the same teacher often remains in year 6 over several years. The few consistent trends appeared as follows: In school GL girls do well in English and are improving in mathematics. Girls appear to do less well in mathematics in schools LL and MA. In school MA the 2001 scores appear to be significantly better than for other years. The overall trends need to be read alongside summaries from each year since the variation is important from a Complexity Theory perspective.

Approach 2

The use of progress levels appeared to give further insight into where teaching strategies might be promoting rapid advancement across the levels. In particular, this analysis highlighted the progress being made by boys in school GL and to a lesser extent by girls in the same school. It should be noted, however, that lower levels at key Stage 1 allow more progress to be demonstrated in Key Stage 2, which means that more progress in one school does not necessarily imply more effective teaching.

Approach 3

This demonstrated that age distribution across the schools was relatively even suggesting that age differences would not account for differences in progress made. The cluster technique raised the possibility of looking for patterns of attainment across several variables. Older pupils, for example, appeared to make better progress in English, perhaps because they respond better to styles of teaching and learning which call for greater responsibility being taken by the pupils. It also showed that for above average pupils their English mark was often better than or equal to their mathematics mark. For below average pupils mathematics was often their better mark. This might support arguments that attainment in mathematics is dependent upon attainment in literacy.

The clustering techniques trialled here are the least convincing at this stage since they rely on a 'hidden' process within the SPSS software. I suggest that taking these clusters as a starting point, along with comparisons made in approach 1, and then working to amend and validate them with teachers, might lead to useful categories of attainment. These categories correspond to attractors in Complexity Theory terminology. After undertaking qualitative analysis with observational and interview data it will be useful to compare the insights gained from this performance data. I was concerned to avoid 'confronting' schools with the analysis produced in this chapter since I believed that this might alienate teachers. I have begun to use the approaches and findings sparingly with teachers and advisory colleagues when the time seems right and in the spirit of stimulating discussion.

Chapter 8 Towards a Fractal Typology and Description of Attractor States

Introduction to the Data Analysis

As explained in previous sections the principal focus of this work is on learning in schools. Data has been collected to allow comparisons to be made between the perspectives of different sections of the school community. In this chapter I will explain how Complexity Theory and Social Activity Theory have influenced my data analysis and how I have processed the data from the observations and interviews in the three schools in the study.

Initial Organization of the Data

The interviews and discussions were transcribed as previously explained in the methodology chapter and organized along the following lines. Within each school, comments from students, teachers and senior managers were grouped according to whether they referred to the learning of themselves or other students, teachers or senior managers, and their own perceived influence on the learning of others. By further grouping combinations of these I was able to build up a picture of perceptions of learning at each of five levels which I believed might reveal interesting Complexity features. These are; student level, class level, teacher level, school level and senior manager level. I enclose a table describing the comment banks combined at each level. The student, teacher and senior manager levels comprise individuals either making statements about themselves or having statements made about them. Class and school level refer to collective learning or conditions which promote collective learning. It will be noted that there is duplication of the use of data banks across levels. This is because a person's own learning will often be closely bound to the learning of others. Comments made by a student on her own learning, for example, will also reveal attitudes to and impressions of learning activity within the class as a whole.

Table 8.1 Description of comment banks linked to level of analysis

LEVEL	COMMENT BANK
Student	Students on their own learning Teachers on student learning Senior managers on student learning Students on other student learning
Class	Students on other student learning Students on teacher behaviour influencing learning Teachers on their perceived influence on student learning Senior managers on teachers influence on student learning
Teacher	Teachers on their own learning Teachers on their perceived influence on other teachers' learning Senior managers on teachers' learning Students on teacher behaviour, making changes according to feedback.
School	Teachers on teachers influencing each other's learning Senior managers on teachers learning from each other and the way developments and changes are made in the school.
Senior Manager	Students on senior manager behaviour influencing learning Teachers on senior manager behaviour influencing learning Senior managers on their own perceived influence on pupils Senior managers on their own perceived influence on teachers Senior managers on their own learning

It became apparent early in the process that it was important to identify sections of interview text along with supporting context and observations drawn from Learning Episodes and my field notes. I reasoned that these could be considered as an 'event', in that they contained the expression of a significant opinion or reaction. The sections of interview text which form the centre-piece of an event are referred to as 'text sections' and usually comprise the utterance of a single individual in answer to a question. They range in size from one short sentence to a full

paragraph. I identified 63 events which I felt confident about coding against at least the first four dimensions in table 8.6. These were used in my initial analysis.

Key Questions about Learning

The two key issues that interested me initially concerned how people in different positions within the school community view what it is that is most important to learn and how the same respondents view the way people learn most effectively. Skidmore [2003] notes that one of the ten key principles of assessment for learning as identified by the Assessment Reform Group [2002] is a focus on the how and what of learning. These two areas of interest have also emerged during discussions with teachers over a number of years and reflect tensions which permeate activity within schools and within the advisory team. When colleagues discuss these issues, they reveal their priorities and the strategies they use to cope with conflicting pressures of time, internal and external accountability and their own beliefs about the aims of education and how these should be achieved. I wished to explore the tensions in a more systematic way and believed that such an exploration might enable me to identify patterns which would help understand effectiveness in schools from a Complexity perspective. These two dimensions can be formulated in a number of complementary ways.

a) What it is that it is most important to learn.

The discussion in this dimension concerns whether it is important as a learning objective to prioritise learning about learning (metacognition) and problem solving skills or a particular body of knowledge. Bereiter [2002b] formulates this as a distinction between a focus on soft or hard skills¹⁴. In Social Activity Theory the distinction lies between whether the principles of evaluation relate to the learner or the content. I use the terms 'Process' and 'Content' to summarise this distinction. Clearly most lessons and professional development activities will involve a

¹⁴ The distinction also corresponds to that of Gilbert Ryle [1949], 'knowing how/knowing that'.

combination of these objectives but the important issue is one of priority. At the extremes are colleagues who make distinctive claims about the objects of learning. Those prioritising 'content' claim that for one reason or another the 'basic skills' have to be learnt first and that the inculcation of a body of knowledge is the prime aim of education. Colleagues prioritising process, however, claim that the principle objective must be to equip students with a 'tool box of strategies' for learning and solving problems. These colleagues would also claim that by prioritising metacognition, appropriate content is covered and understood by the learner. I need to stress here that I am not arguing for a particular epistemological position, or for the veracity of the process/content distinction. There are compelling arguments against considering knowledge as an entity which can be contained. My motive is rather to organize the data using a distinction prevalent in the discourse of professionals involved in the study and beyond.

b) How people learn most effectively.

The second dimension is closely linked to the first and refers to the way in which it is perceived that learning takes place most effectively. This might be formulated as a distinction between constructivist and behaviourist models of learning or in Bereiter's [2002b] terms the 'Design Mode' of knowledge working versus the 'Belief Mode'. Social Activity Theory might construe this as the principles of evaluation being located either internally or externally. I have used the labels Research and Adoption for the priorities within this dimension. I characterise the extremes of colleagues' views in this dimension. The prioritising of 'research' suggests that learning activities should be designed which involve trial and improvement and the making of decisions by learners. Those advocating adoption might claim that either the best solutions are already identified or that there really is not time to spend on more 'open-ended' work.

These two dimensions are closely intertwined since a teacher who prioritises metacognitive learning objectives will be more likely to build in activities which give

pupils the freedom to explore. The tensions referred to earlier are very powerful and may for example result in a teacher who would wish to experiment with her own practice deciding that, because of external pressures, this is not possible and she will need to adopt a way of working from elsewhere. The other issue here is about whether there may be different approaches to learning appropriate for different purposes. In other words it may be consistent to move around within the dimensions outlined above. I expected that this would be apparent when looking at responses to questions about learning. However, I was interested to find out if the frequency of references to learning characterised in different ways could be used to define an approach to learning within a school. My first step was to construct a typology based on the two dimensions. Since the dimensions are closely interlinked there will be four categories created as are shown below.

What is it most important to learn?

		Process Emphasising the development of the skills of learning	Content Emphasising the acquisition of content knowledge
How does learning take place most effectively?	Ultimately through research and self directed activity.	Research-Process (quadrant A, A1)	Research-Content (quadrant B, B1)
	By adapting to external demands and adopting good ideas and practices from elsewhere	Adopt - Process (quadrant C, C1)	Adopt - Content (quadrant D, D1)

Figure 8.2 A Proposed typology for Investigating Relationships between Perceptions of How and What it is Important to learn.

Examples of Coding in the Typology

I coded the sixty three data events against the four quadrants of the typology. This involved difficult decisions because of the inter-relationships between the dimensions and the question of priorities discussed above. Some examples might clarify this process. I give examples of sections of the events coded in each quadrant with a short commentary explaining the decision for the eventual coding. I also grouped the events by level and quadrant and was able to explore similarities and differences between levels and construct typologies to illustrate these. By way of illustration I have arranged the text sections by level for each of the four quadrants.

Research-Process, Quadrant A

In these extracts I judged that the development of process skills takes priority and that this is achieved by undertaking relatively open-ended activities.

Student

Pupils in some classes revealed a Research-Process agenda. The task for the following lesson involved sorting 2-D shapes according to different criteria. Students were encouraged to experiment with their own methods of representing their results. The representation of the results was regarded as more important than the sorting criteria. The student respondent was aware that different approaches were being taken and appeared to view as important the way in which she had worked (experimental) and the variety of representations reached by class members.

RC: did everyone sort them the same way?

Y5 student g: no we did them in different ways, I started on like a graph, not a graph, like a table and then I went, on the back, say it was isosceles in a bubble then I had a line going down and whatever triangle it was I would write it in a bubble

These students appeared to be reflective about the way collaboration assisted the learning process.

Y5 student j: there were questions that I wouldn't have thought of before

Y5 student g: Its easier when you are in groups because you are not just getting your own ideas, your friend who you are with is helping get other ideas

Y5 student j: its nice to share your ideas

Y5 student g: you put all the ideas together and get a bigger idea

Y5 student h: Its good as well because in four sometimes you don't want to ask in case it looks as though you aren't brainy, but in two you get more of a chance to listen

class

The teacher quoted below expresses her views about how pupils learn and what is important to learn, but also indicates the importance of the class dynamics in the process. This is indicative of the type of activities which are designed for students to undertake and the outcomes which the teacher is prioritising.

Teacher: I think it was the interactive nature of the lesson, the fact that the pupils were problem solving, taking away reports and analysing each paragraph for themselves rather than having the teacher say, this is a report, these are the main features. The finished piece is not the main thing, it's the whole process.

Teacher level:

The teacher here is amending her practice on the basis of observed pupil learning and on the basis of pupils' own comments generated through the use of Living Charts and the WIL and NIKI system. Learning about learning is placed at the centre of her own practice and that of the pupils. She prioritises 'opportunities for learning' above that of specific learning outcomes.

Teacher: By nature I am always evaluating what I have done after each lesson, in terms of how much the children have learnt and if I have created maximal opportunities for learning. I do make rough notes from time to time which are important for me.

Senior manager

Research-Process attitudes are expressed at different levels. The Headteacher quoted below saw himself as a lead learner who encouraged experimentation by teachers and students. The headteacher himself experiments with learning activities aimed at promoting pupil self-expression, and at the same time models the approach for the teachers in his school. The fact that the headteacher takes the time to do this reinforces the approach and defines him as a learner and experimenter. It makes a statement about what is most important in the school and how learning should be promoted.

Headteacher: I took fifteen children to the local reservoir to look at the clouds and the reflections in the water.

They made sketches with pastel, now we have bought some nice canvas and water colours and they can produce attractive paintings.

I took them out in the minibus and used an investigational approach to try and prove that it can be done in any subject.

Research-Content. Quadrant B

In this quadrant trial and improvement is involved but the desired end-point is clearly defined in terms of curricular targets.

teacher

A teacher makes judgements about the success of her teaching approach based on pupil progress measured against a progression of skills.

Teacher L: We have had to blitz certain things some days but we found last year that our writing skills improved upon introduction of the First Steps pilot in year 6 based on the targets we had set. So we have used this to modify our targets for this year. I'll be interested this year to see how they perform, obviously a different cohort of children.

The following teacher judges pupil understanding against a set of target content objectives which are contained in a target booklet given to each pupil. She amends her practice on the basis of the successful completion by pupils of the targets.

Teacher: Whatever is best for the children, I'm gauging that and changing things. I talk to children and say 'explain this to me' and I can see how well they have understood what I wanted.

School

At a school level, a group of teachers experimented with the form of record keeping but did not question the emphasis on curricular targets. Teachers on the staff were willing to let coordinators make decisions for them and expected ideas and systems to be presented fully formed. Although there was a degree of research by some teachers the final record keeping system was adopted by the majority.

Maths Coordinator, Teacher S: Well, when I arrived we had target cards. People were not getting the targets from a specific place. There wasn't much progression in the targets and the targets were very general. We got together and decided that we should set the targets from the numeracy and literacy strategies. We got together and decided that the system wasn't working. Too much time was taken up thinking of targets. So I did the numeracy targets and J set up the literacy ones.

Adopt-Process, Quadrant C

In some cases I judged that there was little adaptation and amendment of strategies learnt elsewhere although the programme involved pupils in learning about learning, hence the coding in this quadrant.

School level

This teacher was willing to take ideas from other colleagues and to support their introduction across the school if they prove useful. In the following extract the ideas referred to were 'cascaded' from an external training day.

Teacher L: My two Year 6 colleagues took on many of the ideas, we plan everything together. Other staff started asking questions about the approach and saying 'That's interesting, can you tell me some more about it?' I did some short sessions in staff meetings and then a whole training day. Staff started to introduce it into their own lessons at their own pace. I had more staff meetings and discussions with individuals. We then purchased the materials and had a follow up training day which focused on writing, going into a lot of detail.

Since then I have kept up the momentum through short inputs on training days and staff meetings.

Senior manager level

Although the need is expressed to undertake some external initiative or meet some requirement this can be amended to fit with procedures already in place as is expressed by the following senior manager. He explains how the school manages to maintain a focus on the process of learning while meeting external requirements.

senior manager: I suppose we are lucky in Wales that we can take what we want from initiatives.

The teachers can use their knowledge of the children and move new initiatives around to fit into our program here.

Its almost like weaving, the outside influences have to be woven in with the things that we are doing here.

The same headteacher emphasises that his staff should not feel threatened by external demands.

Headteacher: The teachers never see the initiatives as frightening. I say, you are the boss, you are the inventive one and your children have to work with you. They have taken on the numeracy and literacy hour quite effectively.

Adopt-Content Quadrant D

This quadrant is perhaps the easiest to code. Events here refer to a learning objective which is externally defined.

Student level

The student below appears to accept that he will learn best by adopting the teacher's method and that it is important to acquire a set of skills

RC: What helps your learning?

Student a: The teacher doing lots of examples.

Students were aware of different modes of working, pre and post SATs and of the pressures of these tests. The teacher claimed that there is just one term when 'cramming for the tests' takes place. It appears that this experience has made a deep impression on the students. In the lead up to SATs the aim is to 'get the correct answers', whereas after SATs they return to a more collaborative and problem solving approach. This exemplifies the difference between the Research – Process and Adopt-Content modes.

RC: Sounds like you do a lot of thinking.

Y6 student c: before SATs we had a lot of thinking to do but now they are over we are relaxing.

Y6 student d: We are not exactly not working, we're doing things we weren't doing before in our subjects like maths science and English, its more fun and also we are doing more geography and history, the teacher says don't worry if you get it wrong.

Class

This student appears to view collaborative learning as getting 'the answer', from other people.

RC: so does showing your answers help

Y5 Student G: yes because if you didn't know how to do it you could look at someone else's and ask them how they did it and they could show you.

In the following school the students' enthusiasm for specific content targets was matched by their teachers. The teachers had a clear view of need for objectives to be stated to pupils. The teacher was keen to draw different strategies from the pupils but the ultimate aim was the more effective absorption of curricular targets.

Teacher S: I think reinforcing the targets and making clear to the pupils what I hoped they would learn, also thinking of different strategies and showing them that there are many ways to do something, making the strategies work for them as well, not just saying this is how you do it and getting them to come up with ideas. Reinforcing all the time, coming back to the targets.

School level

A senior manager in the following school aimed to find the best solutions to perceived problems within the school, and this she did by looking for answers outside the school. She set the agenda of improvements which were referenced against external criteria. In this case the immanent inspection of the school provided the impetus for this work.

Deputy Head: I'm trying to get everything together on self development for our inspection. So we could do this for an area of literacy as well? By the end of Christmas I hope to have another area covered by the same process. We identify a weakness and then delve into it using this method of focusing on learning.

Distribution of the events by level and school: A heuristic device.

I made no attempt to define learning at the beginning of the interviews. My aim was to allow respondents to choose the type of learning to refer to when formulating

their reply. Clearly a respondent may reply in different ways according to the learning situation they have in mind at the time. I reasoned that although no single statement could be taken as representative of the views of a respondent, the distribution of coded events across schools could prove revealing. I had also coded the events by level as previously described, so the distribution by school and level could be displayed.

Table 8.3 Summary of percentage of text sections coded and sorted by What / How learnt. (note, percentages are of events for each school)

School	GL				LL				MA			
Level\quadrant	A	B	C	D	A	B	C	D	A	B	C	D
student	4	4	0	8	8	0	4	4	0	0	0	23
class	8	4	0	0	0	0	12	8	0	0	15	23
teacher	12	0	4	0	4	0	8	4	0	8	8	0
school	16	0	8	0	4	0	8	8	0	8	0	8
Sen. Man	4	4	24	0	4	0	16	8	0	0	0	8
Totals	44	12	36	8	20	0	48	32	0	15	23	62

The quantification of coded sections is not intended to signal a traditional statistical treatment but serves to summarise the coding to date. There is little justification for making judgements about the three schools based on the distribution of the coded events. Some early hypotheses may, however, be constructed on the basis of this distribution. The initial coding Portrays school GL as being primarily quadrant A and C, school LL as quadrant C and D, school MA as mainly quadrant D with some quadrant C. This suggests that in school GL process takes precedence over content and that ideas are either worked up within the school itself or taken from

elsewhere and adopted where necessary. School LL emphasises the adoption of ideas, some of these involve learning processes and the rest emphasise content. In school MA, learning particular content and adopting procedures from elsewhere appears to predominate.

An important outcome is that in school GL students were able to differentiate between a Research-Process and Adopt-Content mode of working as exemplified by the replies from students when questioned about different learning activities before and after the National Assessment tests (SATs).

RC: Sounds like you do a lot of thinking.

Y6 student c: before SATs we had a lot of thinking to do but now they are over we are relaxing.

Y6 student d: We are not exactly not working, we're doing things we weren't doing before in our subjects like maths science and English, its more fun and also we are doing more geography and history, the teacher says don't worry if you get it wrong.

The 'things that were being done differently in Maths and English' were more open-ended activities after the tests. Clearly, leading up to the tests making mistakes was regarded as unhelpful whereas after the tests making mistakes was seen as a necessary part of learning. Two hypotheses tentatively arise from this. First that it appears a test-driven curriculum fosters an Adopt-Content approach, and second, that those within a Research-Process perspective have a greater awareness of different modes of working.

Clearly the coded events are not representative nor have they been collected systematically, however this provides a picture of perceptions of learning in the study schools which can be compared with material from other sources. Given that the events were also coded by level, I was able to compare differences across these levels.

Similarities and Differences at Each level in the Research-Process Quadrant.

At student level, participants were able to talk about areas where they controlled how they learnt and could also point to a variety of outcomes. Teachers also saw experimentation as legitimate and important. Senior managers not only condoned this way of working but were ready to experiment themselves. Because of their position this experimentation was somewhat muted since they felt the full force of external accountability. They appeared to feel responsible for shielding pupils and teachers from external demands and much of their creativity revolved around meeting external demands while retaining practices developed within the school. Class and school-level responses contained many similarities, with teachers and pupils given a significant degree of autonomy. Outcomes in both cases were evaluated by reflecting back on the process of learning and whether or not further strategies for learning had been developed.

By considering the similarities and differences in coded events at each level I have produced the following tentative typologies. The status of the typologies at each level is unclear at present. I view them as working documents which require further elaboration by the consideration of rules, roles and positions at each level. Class and School level comprise a composite picture of the explicit and implicit rules for learning. Student, Teacher and Senior Manager levels could be further analysed in terms of roles and positions. I foresee further elaboration of these typologies as being useful for my future work in schools since it will allow pupils and teachers to reflect on their priorities. The portrayals below summarise the present state of my perceptions of the respondents coded at each level.

Student Level

What is it important to learn?

	Process	Content
How does learning take place most effectively?	Ultimately through research and self directed activity.	Students value working on extended activities and monitor their own learning.
	By adapting to external demands and adopting good ideas and practices from elsewhere	Students value the attainment of discrete targets.

What is it important to learn?

Class Level

	Process	Content
How does learning take place most effectively?	Ultimately through research and self directed activity.	Patterns of working established to maximise participation of students and to focus on enquiry methods
	By adapting to external demands and adopting good ideas and practices from elsewhere	Teachers adopt models of teaching and learning from elsewhere which it is believed will develop student's meta-learning.

Teacher Level

What is it important to learn?

Process

Content

How does learning take place most effectively?

Ultimately through **research** and self directed activity.

Teachers value working to try out new ideas with a view to improving own effectiveness as a teacher and as a learner.

Teachers value working to try out new ideas with a view to improving own effectiveness as a teacher as measured by pupil results.

By adapting to external demands and **adopting** good ideas and practices from elsewhere

Teachers value received ideas and practices believed to increase own effectiveness as a teacher as measured by external standards. (e.g. Hay McBer)

Teachers value received ideas and practices believed to increase own effectiveness as a teacher as measured by pupil results.

What is it important to learn?

School Level

Process

Content

How does learning take place most effectively?

Ultimately through **research** and self directed activity.

Staff encouraged to take opportunities to trial working practices which enhance the learning and metalearning at all levels.

Staff encouraged to take opportunities to trial working practices which enhance pupil results

By adapting to external demands and **adopting** good ideas and practices from elsewhere

Staff adopt models of whole-school working from elsewhere which are believed to be examples of best practice as indicated by external agencies (eg. HMI, OFSTED, ESTYN)

Staff adopt models of whole-school working from elsewhere which are believed to be examples of best practice and which will maximise pupil results.

Senior Manager level

What is it important to learn?

		Process	Content
How does learning take place most effectively?	Ultimately through research and self directed activity.	Senior manager sees self as a lead learner, modelling experimental practice and encouraging and providing opportunities for teaching colleagues to do likewise.	Senior Manager sees self as a leading practitioner with a reputation for effectiveness measured by pupil results, and who works with teachers to develop teaching skills.
	By adapting to external demands and adopting good ideas and practices from elsewhere	Senior manager sees self as knowledgeable about models of teaching and learning and whose role is to organize appropriate INSET for staff and monitor their performance.	Senior manager sees self as performance manager of staff where success is ultimately measured by pupil results.

Figure 8.4 A Proposed typology for Investigating Relationships between Perceptions of How and What it is Important to learn, at several levels.

Using the typologies at each level a further display of the predominant responses by school, level and quadrant could be constructed. This is valuable in that it reveals the consistency (or otherwise) between levels. These provide an alternative view to the distribution of events coded simply by quadrant and present a picture of the levels within schools from the data collected at a particular point in time. Unfortunately this does not portray the dynamic, changing nature of the best descriptions within schools. Such change trajectories could be introduced if data was collected at more than one point in time. These typologies should be regarded

as tentative, but could form the basis for work on a larger scale where they would be further refined.

A Summary by Quadrant, School and Level

(showing predominant coding of text sections by level in each of the three schools, GL, LL, MA)

		What is it most important to learn?		
How does learning take place most effectively?	Research-Process, quadrant A	Research-Content, quadrant B		
	Student:	GL, LL	Student:	GL
	Class:	GL,	Class:	GL MA
	Teacher:	GL, LL	Teacher:	MA
	School:	GL	School:	
	Senior Manager:	GL	Senior Manager:	
	Adopt-Process, quadrant C	Adopt-Content, quadrant D		
	Student:	LL	Student:	GL, LL, MA
	Class:	LL, MA	Class:	LL MA
	Teacher:	LL, MA	Teacher:	LL
	School:	GL, LL	School:	LL MA
	Senior Manager:	GL, LL	Senior Manager:	LL MA

Figure 8.5 Summary by quadrant, school and level of predominant coding of text sections.

Again, this suggests that in school GL process takes precedence over content and that ideas are either worked up within the school itself or taken from elsewhere and adapted where necessary. School LL emphasises the adoption of ideas, some of these involve learning processes and the rest content. In school MA, learning content and adopting procedures from elsewhere appears to predominate. Schools GL and MA appear relatively consistent across levels within their predominant quadrants. School LL, however, supports a variety of attitudes and opinions. It needs to be emphasised again that the text sections are not selected in a systematic way across schools and levels and thus cannot be used to form definitive judgements. If a systematic approach were built in over time a greater degree of generality would be attained.

Increasing the Delicacy of the Analysis to include other dimensions

Apart from the coding of school and level the following two dimensions have been considered in the previous section:

- a) What it is that is most important to learn.
- b) How people learn most effectively.

In order to consider the significance of what people say and do about learning I reasoned that it is important also to gauge the following:

- c) The position that the respondent holds in the organization.
- d) A measure of their control over what they do.
- e) The degree to which they collaborate with others in learning activities.
- f) The way in which conflicting demands are resolved by respondents.

These four considerations (c,d,e, and f) were motivated by Social Activity Theory (SAT), Paul Dowling [2001]. I decided that it would be useful to analyse my

interview material in detail suggested by SAT to enable similarities and differences at each level within the schools to be explored. Without this analysis the all important tensions and contradictions which motivate and demotivate change would remain invisible. Respondents' utterances and their actions have to be viewed together since, as Fullan [1999] notes, changes in belief and attitude often come after some changes in behaviour. I will be attempting to map changes in all five of the points a) to e) above at pupil teacher and school level along with reaching some understanding of the conflicts between them and how those involved resolve these (point f)

Dowling's categories have been described previously (see chapter 5). The level of consistency and conflict management was judged against two criteria; whether the behaviour referred to could be classed as indicative of a role, activity or strategy, and whether it was generalized or specialized. The balance of authority was judged to be either at the level of the author of the statement, or at another level. This was further supported by a judgement about the level of negotiation (high or low) involved in the initiation of the behaviour. Respondents may express views about learning which reflect their understanding of the organization's policy. By investigating where the authority behind such statements lies, and the extent of negotiation which has preceded establishment of policy, I reasoned that it may be possible to judge commitment to and degree of internalization of the ideas expressed. A full summary of the dimensions utilized in this later analysis is shown below.

Table 8.6 Summary of dimensions used in coding of events

DIMENSION	ELABORATION
What is learnt	Process, content
How it is learnt	Research and development, adopting solutions
Where authority lies	Within own level, at another level or shared
Control over activity	Level of negotiation (high or low)
Collaboration	Positive or negative attitudes towards
Consistency	Role, activity, strategy
Conflict management	Generalizing, specializing

I also wished to explore the degree of alignment between views expressed about learning at different levels. This was motivated by Complexity Theory which suggests that optimum solutions emerge mid-way between too much and too little order. In physical systems this is exemplified by the consistent application of simple local rules, and the replication of such rules at different levels. I was interested to discover how much consistency there was between levels and between schools, how respondents dealt with contradictions and tensions between their views and the imposition of external requirements (and practical requirements). These tensions and the way they are handled indicate individuals' and organizations' capacity for handling change and for learning. Such tensions may also provide an important spur for learning. Complex Adaptive Systems (CAS) manage tensions and demonstrate flexibility in the face of changing circumstances. They manage rather than suppress dissent. Fullan proposes that as educationalists we should regard 'conflict and diversity as our friends' [Fullan, 1999, p18], which is compatible with Complex Adaptation. Fullan also points out that collaborative cultures provoke discussion and debate but also contain and manage anxiety. Through an investigation of the level of collaboration within and between levels in schools I hoped to achieve some understanding of schools as Complex Adaptive Systems.

Practical Considerations of the Additional Coding and Analysis

Within NVivo, I coded each text section against the dimensions outlined above in table 8.6. I was then able to use the Boolean search facility to investigate similarities across schools and levels. I began by attempting to identify key elements within each level and each school in an attempt to locate the dimensions defined above. Given the time scale of the thesis I had difficulty in viewing changes in these groupings within schools over time and had to rely on respondents' impressions of these. To map the trajectory of such changes over time by interviewing the same respondents again would be a powerful indicator of change management within schools and may be utilised at a later date. I first describe my coding of Authority and Negotiation and provide examples of the coding decisions made.

Coding Authority and Negotiation

By way of illustration I provide some sections from pairs coded events which show contrast. These are all within the Research-Process quadrant and involve contrasts between shared authority / authority with others and where negotiation is high contrasted with low levels of negotiation.

Authority shared

In each of the sections below I judged that the student was equally willing take the lead and to respond positively to the ideas of other students.

RC: Do you like working with other students?

Y6 student a: Yes, when you are in a group everyone should have a go, and everyone should agree on what to do, so one person doesn't just put in their ideas.

Y6 student b: Its harder on your own, when you are in groups you share ideas and work as a team to come up with a solution. When you are on your own you've only got one brain.

*Y6 student a: Its easier because there are more brains
If you get stuck other people can help*

Authority with other

This student appeared to be acknowledging that the teacher was the source of authority in these instances.

Y6 student: If there is something we don't understand she will give us a different version so we can understand it more easily.

Y6 student: She writes comments, and targets for us like 'make your handwriting neater' that's when you have to do your work neater. Sometimes she asks you a question and you have to try and answer it

Y6 student: She says how you can improve your work.

Y6 student: instead of telling us once and leaving it, the teacher takes it slowly and lets us have a think about it before she carries on.

Y6 student: She helps us as well and checks our work and makes sure everyone knows what they are doing, she explains things and tells us what to do if we need to catch up.

Negotiation high

The Headteacher saw teachers as collaborators and encouraged them to develop individual teaching styles. He was expressing the view that teachers were able to negotiate what they taught and how they taught with each other. He was also condoning their way of working, acknowledging the right of teachers to act independently within certain limits. In other words the headteacher acknowledges their professional status.

Headteacher: They plan together about two to three weeks ahead, looking at the scheme of work and the needs of the children.

The short-term planning means that each teacher will be doing the same sort of work in their individual ways, how they deliver it is not prescribed.

If you watch these teachers at work in this school then you see that every break and lunchtime they are sharing information on how the pupils have done right across the board in all subject areas.

Negotiation low

The same headteacher quoted above had a clear idea of the overall approach to teaching and learning. It is unlikely that much negotiation about this general approach to teaching would be accepted. He has hand-picked teachers over a number of years who agree with his approach to teaching and learning. He was actively engaged in teaching and in modelling interesting approaches to teaching and learning as the extract above shows. By personally modelling the desired approach the headteacher makes it difficult for dissent to take root.

Other Coding

Collaboration, consistency and conflict management were coded but I believe with less reliability. Collaboration was almost universally regarded as being positive. I was aware that collaboration meant different things to different respondents and my data collection did not appear to distinguish between these. The level of consistency rested on a judgement about how firmly established the practice was. In some cases it was not clear how generalised the practice might be. I decided to work with the material I had in this case since the thesis is essentially exploratory. These three dimensions figured less strongly in future analysis. There are lessons to be learnt for future projects, in particular that follow-up questions may need to be asked which allow the researcher to access respondent's understanding of the term 'collaboration'. It needs to be emphasised that none of the interviews, lessons or coded sections of text are considered as 'representative'. As explained in the chapter on collection of data my aim is to explore trails within the data and not to establish generalisable results. The resultant coding and organisation of the data allowed further analysis. On the one hand I was able to gather all the material and attempt a summary picture at each level. This is given immediately below. I was also able to experiment with the use of facilities in SPSS which would be useful for larger samples and which is discussed in following sections.

Using SPSS to attempt clustering of all dimensions.

Complexity Theory suggests that keeping all the variables in the frame is important since variables in combination are more than the sum of the variables considered singly. Working with nine variables at once presents a formidable challenge and although, to some extent, this may be possible with a small sample it would certainly be impossible with a large one. I wished to explore ways in which this might be possible utilizing the K-Means cluster facility in SPSS as suggested by Byrne and Rogers [1996]. Having undertaken an analysis of the above data involving coding of text sections it was then a relatively easy matter to enter these

codes into SPSS. I was able to explore the possibilities of the K-means cluster facility and compare this with the work I had already completed. The K-means cluster facility within SPSS works by attempting to group 'similar' cases together. The operator specifies the number of clusters and the variables to consider. The software then runs iteratively, coming up with the best fit and measuring the distance of each case from the ideal in each cluster.

One issue that arose was the relative confidence placed in different codes. To some extent this may be allowed for when the researcher is viewing and sorting the data manually. In SPSS, however, all codes are given the same weight. I was aware that this might skew the resultant picture. As previously mentioned collaboration was almost universally regarded in a positive light (even though collaboration meant different things to different people), for this reason it was left out of the cluster analysis. I was less confident about the coding of 'consistency' and 'conflict management' than the other variables. On reflection I decided that 'Authority' and 'Level of negotiation' were two of the more influential variables. In the end I ran the K-Means cluster with How and What was learnt, authority and level of negotiation. The four following clusters emerged. I was heartened by the fact that these corresponded to the four quadrants which I had identified previously, although membership of each cluster did not fully correspond to my manual approach. The four clusters produced are described below with reference to the most common clustering of What is learnt, How it is learnt, Where authority is positioned and How authority is negotiated:

Quadrant A1: Research – Process, Authority shared and negotiation high

Quadrant B1: Research – Content, Authority at another level and negotiation high.

Quadrant C1: Adoption – Process, Authority at own level and negotiation low.

Quadrant D1: Adoption – Content, Authority is shared and negotiation low.

The K-means cluster groupings appear compatible with my descriptions of the quadrants from the applied coding. It appears consistent that in the research

quadrants (A1 and B1) negotiation is high, since it is in the nature of inquiry, trial and improvement that participants share ideas. Authority is shared or at the author's own level when process is a priority (A1 and C1) which is consistent with active participation. Negotiation is low in the Adoption quadrants (C1 and D1) which matches the definition of adoption as whole-hearted acceptance of external ideas.

I summarised the occurrence of text sections in each quadrant as had originally been undertaken manually. This is shown in the table below. Again, this quantification has limited statistical validity, it's value lies in the fact that it acts as an heuristic device.

Table 8.7 Summary of percentage of text sections coded and sorted by K-Means Cluster

School		GL				LL				MA			
Level/quadrant		A1	B1	C1	D1	A1	B1	C1	D1	A1	B1	C1	D1
student		4	0	12	0	4	4	4	4	0	0	23	0
class		0	12	0	0	4	4	16	0	0	0	23	8
teacher		4	12	0	0	0	4	0	12	0	8	8	0
school		16	8	0	0	4	0	4	12	0	8	8	0
Sen. Man		16	8	0	8	0	4	4	20	0	0	0	8
a)Totals	K-	40	40	12	8	12	12	28	48	0	15	62	23
means													
cluster													
b)Totals		44	12	36	8	20	0	48	32	0	15	23	62
original													
coding	for												
comparison													

Row a) in the table above shows the total percentage of text sections coded in each of the four clusters A1 to D1. This is compared with the original coding in row b). The overall totals show similarities, although in school GL a large number of the coded statements change quadrant when the K-means cluster facility was

employed . In school GL the emphasis is on research and process in both the original and K-means coding. The emphasis in both schools LL and MA is on adoption and product. Since there was no attempt to control the number of statements across levels the percentages above give no more than an indication of the balance across the interview material (as perceived and coded by myself as researcher).

I experimented further with the number of clusters and the number of variables included when using the K-means cluster facility. In conclusion it appeared that four clusters best described the set of cases with, in this case the best match between the manual and K-means cluster coding. The distance of each case from its cluster centre was recorded. This could be used to establish the consistency of the clustering but was not followed up at this stage.

Explorations using the Individual Text Sections

I wished to explore the possibility of extending the analysis so that more detailed descriptions could be generated of comparisons between text sections within and across levels. I reasoned that this would assist in the identification of complexity effects. To focus this work I established a number of questions which I then proceeded to investigate using the coded text sections. The questions were:

- Are the conclusions drawn previously about school profiles generally supported?
- Can detailed similarities and differences be detected across levels?
- Are there discernable links between authority and negotiation?
- Are there discernable links between consistency and conflict management?
- Can 'turbulence' be detected using these techniques?

My strategy for addressing these questions was to use the text sections to choose promising subsets. These were then retrieved using NVivo.

Coding in Quadrants and Differences Across Levels

School GL has a predominance of text sections coded as research-process and adopt-process. On closer scrutiny it appears that most of the text sections reveal that ideas were seen elsewhere but subject to experimentation and refinement back in the classroom. To a large extent the difference between the two quadrants refers to the amount of experimentation involved. It also appears that adoption is more likely at school level than student or class level. There may be less room to manoeuvre at school level. Looking across levels there appears to be a consistent commitment to process. These considerations support the research – process profile suggested for school GL.

School LL has a large number of text sections coded as either Adopt – Process or Adopt-Content. Comparison of text section suggests that there is less emphasis on process in the school LL text sections than in those of school GL. Although ‘working with others’ and ‘having time to explore different solutions’ was regarded as important by students in one school LL class, reflection on the process of learning was given little prominence. In school LL the main aim appeared to be the more effective appropriation of content. This difference was even more noticeable at school and senior management level . The one clear exception is at teacher level in one school LL class where experimentation is given prominence. In summary school LL appears to be content oriented, with a mix of research and adoption.

School MA has a predominance of text sections coded as adopt – content. Those in other quadrants show less commitment to either research or process than in schools GL and LL.

Links between negotiation and authority across levels

Use of the K-Means cluster facility created four clusters displaying the following connections between the how and what of learning and authority and negotiation:

Quadrant A1: Research – Process, Authority shared and negotiation high

Quadrant B1: Research – Content, Authority at another level and negotiation high.

Quadrant C1: Adoption – Process, Authority at own level and negotiation low.

Quadrant D1: Adoption – Content, Authority is shared and negotiation low.

These correspond closely to the original four quadrants:

Quadrant A: Research - Process

Quadrant B: Research - Content

Quadrant C: Adopt - Process

Quadrant D: Adopt - Content

I used the method of contrasting individual text sections to investigate authority and negotiation across levels within these clusters.

Authority shared and negotiation high These sections of text exemplify maximum exchange of information and involvement of participants. The Bereiter [2002b] 'soft skills' are being developed and utilized by these respondents. It is significant that school GL has the majority of text sections coded in this way and that many of them are at school level. The K-Means cluster facility indicates a strong association between shared authority, high negotiation and Research – Process. This clearly reflects my view as coder of the material. The other related coding of own authority and high negotiation may seem like a contradiction. I contrasted these with the above. In each case the text section indicates a strong personality who is willing to talk to colleagues/students and share ideas but has a clear view of the general direction in which they want things to move. This direction includes the

development of autonomy in the other (colleague or student. There is a case for creating a more refined coding for 'working towards a shared authority'.

Authority at another level and negotiation high. These text sections complement those coded as own authority – high negotiation above. They are an expression of acknowledgement that the at present more dominant partner has an agenda which includes a move towards greater sharing of authority.

Authority at own level and negotiation low. In these sections respondents indicate that they have a strong personal agenda, often 'for the good of' the school or students. This is clearly associated with achieving some aim, usually adopting a solution seen elsewhere and is linked to quadrant four (adopt – content). The text sections coded in this way are situated at one level and do not appear to stimulate replication at other levels. In the language of school improvement, such responses indicate low levels of 'capacity building' and of ' a culture of whole school improvement'.

Authority is shared and negotiation low. These indicate a non-reflective use of solutions gleaned from elsewhere.

Consistency and conflict management

As previously mentioned I did not feel as confident about the reliability of the coding of consistency and conflict management as the other dimensions. It is clear that coding will vary from those dimensions in which total confidence can be placed (such as 'school') to those with low levels of reliability and validity. Interrogating individual text sections offers the opportunity to refine these codings.

Role / Activity / Strategy This coding referred to my perception of how embedded the talked about practice was. I relied on observation along with consistency of response within and across levels. Roles and actions are associated with greater consistency and higher levels of shared authority and negotiation. Because of this reliance, it is possible that my coding in this case is little more than a replay of previous codes.

Specialisation / generalisation School LL text sections are all coded as 'specialised' apart from one. This suggests that solutions are found at the level of individual problems. Specialisation is linked to low negotiation suggesting that not only are solutions fashioned for individual problems but are also restricted to individual staff or students. This further suggests that collaboration may lead to deeper engagement with the underlying issues involved and hence to more general solutions. Collaboration and generalisation may indicate a higher level of capacity building indicated further by consistent reference to high levels of negotiation and shared authority across levels. I note that collaboration is viewed as positive by almost all respondents. I believe that there are different conceptions of collaboration among respondents which was not differentiated by this work. Greater exploration of respondents' understandings of the term 'collaboration' could lead to exploration of the above issues.

Links between consistency and conflict management could also be explored by identifying links between generalisation and negotiation. When this was undertaken it appeared that high negotiation and generalisation were associated with an emphasis on process as exemplified by the text sections from school GL which are all within the two process quadrants. Generalisation and low negotiation is associated with an emphasis on content. The text sections are all from school MA and are also coded in quadrant four. School MA has been described as focussing on outcomes and using solutions adopted from outside, these being imposed rather than trialled and developed internally.

The Identification and use of Turbulence.

Analysis of data in the broadest sense involves classification either by drawing out or imposing patterns and then, on the basis of this, producing an interpretation. In traditional social science variations from the 'ideal' case are often seen as random variation, which has to be accommodated but which, in itself is not an object of study. Complexity Theory takes a rather different view of these variations. In fact investigation of these 'turbulent' features may reveal whether or not the system is in a state of self-organising criticality. The reader is referred back to the chapter on Complexity Theory. In a nutshell, a Complex Adaptive System exhibits adherence to consistent local rules and a reliance on feedback. Variation from a set pattern of operation is regarded as a positive attribute in such systems since it contributes greatly to the ability of the system to adapt to external changes. In short, such systems evolve over time. Turbulence of this kind contributes to the resilience of the system.

I viewed the text sections with these considerations in mind. School GL appears to exhibit consistency in the reliance on feedback and on reflection at all five levels. The ability to adapt is noted. From the notes in previous sections it can be seen that change and variation is encouraged and expected at all levels. In school MA there is consistency of attitude to the attainment of targets. Variation in this school is minimized with feedback being restricted to the day to day operation of the system. In this case change has a more catastrophic effect. For example, with the appointment of a new headteacher the target booklets were abandoned and work started afresh in different direction. School LL appears to lack consistency with a mixed emphasis on feedback and process and on product. Such inconsistency appears to detract from the school's ability to develop in an evolutionary way.

The above more detailed examination of the text sections provided the impetus for a general consideration of the application of Complexity Theory to this data.

A Summary of coding clusters and implications for Complexity Theory

The prime motivation for this thesis was to explore ways of working with data which would avoid the limitations and pitfalls of more conventional school effectiveness and school improvement research. A second motivation was to investigate whether Complexity Theory had any insights or approaches which would aid in this search for alternatives. It is therefore useful at this point to consider how the analysis above might meet some of these requirements. As a starting point it is worth considering how conventional statistical analysis would utilize the material above. A sample of sixty three text sections is small by the standards of classical statistics. There are techniques for dealing with small samples and , given coding across nine dimensions, one approach might be to work on correlation between these, possibly also using multilevel analysis (perhaps this could be attempted at some later stage). In contrast with this a Complexity Theory approach might be to investigate two issues:

- The degree of replication across levels suggesting some fractal effect.
- The degree to which cases cluster into what could be considered as 'attractors'.

These two issues may be closely linked since replication across levels may reinforce practices making them more permanent and consistent, therefore earning the title of 'attractor'. I maintain that the above analysis supports this suggestion and that two attractors can be identified, both involving replication across levels.

1) Research – Process Attractor: This is exemplified by school GL where:

- authority is with the author or shared
- levels of negotiation are high
- collaboration is viewed positively
- solutions to problems are generalised and it is expected that new solutions will emerge.
- practices are consistently applied
- similar patterns emerge across levels

The fact that authority can be with the author but that levels of negotiation are high points to the presence of confident personalities who are willing to relinquish control but who have a strong vision. It is not clear from the sample above whether this is a necessary feature of this attractor. What may be significant is that 'authority is given to explore research and develop' and that this is practised at each level and consistently applied. Collaboration within this attractor is likely to be defined as 'willingness to work towards a common solution through negotiation when authority is more equally shared and participants are viewed as partners'.

2) Adopt – Content Attractor: exemplified by school MA where:

- Authority is with others
- Levels of negotiation are low
- Collaboration is viewed positively
- Solutions to problems are generalised and are largely taken from elsewhere.
- Practices are consistently applied
- Similar patterns emerge across levels

There is a general relinquishing of control to authority at a higher level within this attractor. Collaboration in this case means ‘working together to achieve the established aims and targets.

There is a level of robustness to the way of working in both of the above cases since desired aims are met (at least in the short term) and practices are reinforced across levels. It can be argued, however, that the Research – Process Attractor offers greater hope for continued evolution, adaptation and development since it builds in the capacity for handling change. The Adopt – Content Attractor relies heavily on the ‘correct solutions’ being presented from outside. I argue that school LL has the worst of both worlds since it does not demonstrate consistency across levels and appears a) not to take advantage of some genuine teacher-led innovation and b) to be unsure about becoming too reliant on ideas from outside and c) struggling to build the capability to move towards the Research – Process Attractor. This formulation is supported by an analysis of pupil performance data (described fully in Chapter 7). School GL shows the ability to promote it’s pupils to make outstanding progress over several years. School MA has in some years made excellent progress up to the target levels in National tests, and in other years has not been so successful. School LL, with a similar intake to school GL, promotes much less progress. Identification of attractor states requires further verification through the study of more schools.

Further implications for Complexity Theory

The overall impression formed is that school GL operates consistently across all levels within the Research-Process quadrant, while school MA is consistently within the Adopt-Content quadrant (again across all levels). School LL straddles Adopt-Content and Research-Content quadrants. In the following discussion I will attempt to relate these impressions to contextual knowledge of the school and links with Social Activity Theory.

Within Complexity Theory there is a preoccupation with two key ideas. First, that interesting things happen on the edge of chaos, that is in a phase transition state between too much and too little order. It is argued that maximum information flow occurs when semi-structured groupings have freedom of movement within the larger system. The second key idea relates to the local adherence to simple and consistent rules. The two key ideas are linked in that relative local autonomy is achieved by agreeing the local rules and then allowing (and trusting) smaller groupings to operate according to these rules. Complexity theorists would argue that conditions are ripe for the emergence of 'optimum' solutions when relative local autonomy is achieved and there is adherence to agreed rules applied locally. I apply this framework to the three schools in the study. School MA has consistent local rules which are institutionalised and authority is with the centre. Given the fact that authority generally resided with the 'higher' level agent the school as a system exhibited too little fluidity and flexibility to support emergent solutions. In school LL authority is shared in some cases and retained centrally in others. Local rules are less well defined in this school. In school GL, authority is shared and consistent, local rules are applied at each level and there appears to be a balance of individual experimentation set against overall structure. A further perception is that diversity is encouraged within school GL and that the anxiety associated with change is managed. In the language of Complexity Theory school GL could be said to be in a state of self-organized criticality.

The conclusions drawn above can be complemented by those from the quantitative analysis chapter 7. It may be remembered that trends in the data suggested that school GL pupils are achieving better than expected results in English. Approach 2 further identified high levels of progress by boys in English at school GL. When considered alongside the qualitative analysis above it could be hypothesised that the Research-Process climate promotes high achievement in standard tests along with an ability to reflect on the processes of learning. Pupils within school GL appeared to be able to articulate the importance of at some times being able to cram for the test while at other times to prioritise aspects of metacognition.

Chapter 9 Discussion and Conclusions

The Main Arguments and Techniques Developed in this Thesis

This thesis has shown that Complexity Theory can add to the range of useful perspectives on change and innovation in education and overcomes some of the difficulties with present approaches. In the conclusion I will first summarise the main arguments which have been presented in support of this claim. I will then outline what I believe are the key original features of my work in this project to date and how this contributes to work on school effectiveness and school improvement. There are, of course, limitations and problems with my own work, which will be discussed next. Finally I will begin to explore the implications of the findings of this thesis on my professional role and for the study and management of change in schools. This final section will include recommendations for future work and research on these issues.

Research activity in the area of School Effectiveness has developed and expanded rapidly over the past twenty years. I have outlined what I believe to be the principle limitations of this work which revolve around assumptions of linearity and the inability to handle the dynamic and complex nature of schools. This is manifest also in School Improvement Projects most of which assume that rational planning against identifiable factors associated with effective schools will lead to steady improvement, and that it is possible for all schools to progress along this route. As I point out in earlier chapters, there are numerous School Improvement projects which place the professionalism of teachers and their professional development at centre stage. These projects also highlight the need to build capability for managing change within the school and largely directed by the school staff themselves. Although these accord with much that is found within a 'Complexity Theory' perspective, there remains an underlying view of cause and effect which supports the identification of key factors for improvement which can then be worked upon in a systematic way. I have argued that there is a need to step

outside of this paradigm, which underpins the mainstream of School Effectiveness and School Improvement, and explore other models of data collection and analysis which might lead to alternative and/or complementary approaches to the management of change in schools. The application of Complexity Theory in social contexts elsewhere, particularly in the field of business, has provided one such alternative perspective.

In pursuing an enquiry into the application of Complexity Theory to education, I started with the premise, expounded by James and Connolly [2000], that learning is central to schools, in two ways, first that pupils go to school primarily to learn and second, that schools and teachers see themselves as learners in a 'learning organisation'. I reasoned that learning involves feedback and that Complexity Theory is particularly relevant to systems in which feedback takes place. It appeared to me that Complexity Theory might thus be of relevance to the study of schools. If it has relevance to business organisations, which might be 'learning organisations' but whose principle aim is not to promote learning then there would appear to be even more reason to apply Complexity Theory to schools. Although the application of Complexity Theory to educational contexts has been suggested, the discussion has been largely at a philosophical level. As one delegate at a recent International conference [ICSEI, Toronto January 2001] suggested, 'The problem with Complexity Theory is to work out how it can be operationalised?'. In order to assess the value of Complexity Theory to education I was determined to attempt to identify empirical indicators by collecting and analysing data. Within physical contexts there have been measures of Complexity developed which often rely on modelling by mathematical equation. These did not appear to be of immediate use in a social context (the possibility of simulation is discussed in a later section). I returned to the notion that learning is central and noted also that teachers and researchers often advocate a focus on learning as being highly desirable. My project then became to investigate Complexity in schools by starting with learning. I was happy that this would be a dialogical or 'evolutionary' process involving trial and improvement since this appeared to be consistent with

Complexity Theory itself. Because of the lack of any relevant empirical work in this area the process resembled that of 'bootstrapping', the term used in computing to designate the self-assembly of computing functions. This project has essentially been a form of action research into my own practice as an adviser linked with the practice of the teachers that I support. It is emancipatory in that it attempts to increase my own professionalism and that of the teachers through the building of the capability for improving practice based on observable changes in pupils' behaviour (even if this change is not immediate). As part of this emancipatory agenda, an Appreciative Inquiry approach was adopted which focused on positive attributes. This was a strategic decision designed to motivate interest in reflection on and discussion about learning among pupils, teachers and advisers.

My next decision concerned the collection and analysis of data. It seemed sensible to include data already collected on school and pupil performance since much of this purported to reflect effectiveness through the promotion of learning and because the analysis of this from a Complexity Theory perspective would provide a useful comparison with more conventional SESI approaches. One aim of the thesis is to show how difficulties in the SESI approach can be overcome. I therefore used school level and individual pupil level data but approached the analysis of these using exploratory data analysis techniques rather than those drawn from classical statistics. I also wished to experiment with data collection and analysis which was motivated from the beginning by a Complexity Theory perspective. In short, this might involve establishing local rules and conditions which when applied consistently over time might lead to the emergence of patterns. Central to this would also be the acceptance of diversity and levels of conflict (even promoting conflict in some cases) and where judgements about usefulness or otherwise could themselves emerge over time without being imposed from outside or reached in haste. Hence the 'Learning Episode' approach was developed in response to this need. These Learning Episodes were used in a variety of ways as discussed in the analysis chapters and which continue to evolve. They can be used as a stimulus for discussion with an individual teacher, in conjunction with other interview and/or

quantitative data, across the whole school teaching staff or published in some way for the scrutiny and use of all teachers in the LEA. The last of these is a long term project which has proved difficult to organise to date. The combined approaches of publishing Learning Episodes and considering exploratory representations of quantitative data indicate the use of hypertext¹⁵.

The collection of Learning Episode and other qualitative data from interviews of pupils and school staff provided the opportunities for further analysis. I was interested to find out if a fine analysis of this data might reveal features of Complexity. In order to do this I utilized the Social Activity Theory protocol, customising it so that comparisons could be made across levels of data and across schools. This work led to the development of a typology linking peoples' perceptions of what it is important to learn and how learning is most effectively promoted across levels within schools. I maintain that this typology can be construed as a set of attractors which are mirrored at different levels within schools. To use slightly different terminology, the typology highlights the fractal nature of a set of attractors which concern perceptions of learning in schools. This typology becomes available for further work with teachers in school in conjunction with new methods of quantitative analysis and the development of the use of learning episodes. The typology is in an early stage of development and will require considerable elaboration as it is used with teachers. This point is discussed further in a section outlining the limitations of this work.

The Main Findings and Implications for My Professional Practice.

I have identified a number of 'Complexity' features within the data collected in this project. These findings are tentative at this stage. Continued data collection over time in the study schools and elsewhere would increase confidence that describing features of the data in this way is consistent, reliable and perhaps above all, useful.

¹⁵ Kress[2003] points out that reading paths through material in hypertext format are more open and dynamic than when simply text-based.

The data from the study schools suggests two attractor states which are defined and discussed in detail in the analysis chapter. These are identified by means of the typology and have been labelled as Research-Process and Adopt-Content attractors. Each of these appears to be exemplified in a study school where the features are observed at different levels. There were variations between levels. For example, there appeared to be less emphasis on research and more on adoption at the school level where it might be more difficult to avoid external prescription. This fractal nature of observable behaviours is also to be expected within a Complexity Theory framework. The school operating within the Research-Process attractor can, I believe, be considered as a Complex Adaptive System. It has the characteristics of a system operating at the edge of chaos, being propelled there by a willingness of the staff to explore novel ideas which may conflict and to allow solutions to emerge from the interplay of these explorations and the local context. There is a balance observed in this school between freedom to explore and structures included in an overall philosophy and approach to learning. This balance between too much and too little structure is an indicator, within Complexity Theory, of an optimum state of evolving effectiveness. That this is the case in terms of pupil learning is supported by evidence from the relative progress made by pupils in the school against National Assessment levels. The third school displayed a more mixed set of perceptions across levels. In such a situation, I surmised that the lack of consistency was leading to reduced communication of the fundamental aims and hence confusion rather than constructive development of teaching and learning.

Following the line of enquiry above, I reasoned that the type of external support which would be most effective in each of the three schools might be distinctly different. This is indeed proving to be the case and the work described in this thesis is acting as a useful guide to this support. In school GL I find that pointing school colleagues in the direction of good ideas can set off a chain reaction of experimentation and development which results in changes in teaching and learning across several classes. Most often the ideas come from the staff

themselves from their own research, reading and In-Service training. My role in this school is generally one of maintaining a critical dialogue with the staff and of recording some of the developments as they unfold for use around the Authority. In school MA, requests have been for fully developed strategies and support along with demonstrations of how to implement them. Recently a new headteacher has been appointed in school MA who appears to be keen to encourage staff to take a more experimental line. In designing staff development sessions with them I have had to take account of the history of adoption of ideas in the school and work more on building up the self-confidence of the staff. School LL remains uncertain of its approach. My intuition is to support Research-Process activity within the school in the hope that some teachers will develop this more fully and it will become embedded in the school. The appointment of a new headteacher is due soon in school LL. There will be an opportunity to choose a candidate who expresses Research-Process attitudes to teaching and learning. The movement of schools between an Adopt-Content and Research-Process attractor is an area which invites further research. Complexity Theory suggests that there may be critical strategies which would act as levers for change and that change between attractors might be more like a quantum leap than a smooth transition. These phenomena, however, have yet to be explored.

A number of interesting patterns and trends were revealed by working with detailed data, both quantitative and qualitative. This analysis is time-consuming but could, in part, be automated using facilities within NVivo and SPSS. Using a delicacy of analysis inspired by Social Activity Theory a number of further Complexity features were noted. These are discussed in full in the analysis chapter but can be summarised here. The Social Activity Theory protocol highlights instances of opposition and alliance, the positioning of authority and levels of negotiation which may be crucial to an understanding of Complex Adaptation. These are elaborated in the two attractor states described in the analysis chapter. A detailed study of these could indicate the state of a system. Where there is little low-level conflict it can be argued that there is limited learning in the Piagetian sense of

accommodation. This, linked with the way authority is shared could provide an indicator of the degree of 'organizational learning' in a school under study. Such identification might then trigger a range of appropriate strategies for support by the Advisory Team.

Detailed analysis of the pupil performance data also proved useful. Three exploratory data approaches were described in chapter 7, which generated questions about the progress pupils had made in each school. For example, the pattern noticed that pupils who achieve higher overall appear to achieve higher in English than in mathematics at Key Stage 2 may bear further investigation since it could provide grounds for more intensive literacy programmes in earlier years of schooling. Other features of Complexity were not pursued in the same detail since they would rely for further exploration on study over time. Some of these are listed. Irreversibility is probably common to all events in a social context and therefore not a significant finding in this work. Autopoiesis, the tendency of systems to maintain their core aims in the face of changes in their operating parts, was apparent in the way schools have retained a teaching approach during staff changes. The issue of bifurcation is an open question. There appeared to be a proliferation of solutions in one school (that in the research-process quadrant), but without study over a much longer period it is not clear whether this represented a continuous splitting into parallel courses of action.

Taken together, the detailed analysis of quantitative and qualitative data provides a valuable resource for work with teachers in school. This, along with the use of learning episodes with individual teachers and whole staffs forms the basis of quite a fundamental shift in the way my working practices are developing which is now described. The focus on learning is undergoing a refinement within the Learning Episode framework. I maintain the Appreciative Inquiry approach but ask teachers and pupils to reflect on what they view it is important to learn and how learning takes place most effectively. This allows a more direct analysis in terms of the typology. I have also started to describe the typology to some teachers asking

them to consider the validity of it and also to place themselves, their students and their schools within it. I am using displays of attainment data developed in this thesis with some school staff. In particular the gender/subject split and comparison is proving useful in stimulating discussion about teaching and learning. Using the exploratory data techniques outlined in Chapter 7, I help focus the discussion on variations in progress made by individuals and groups of pupils. This can then be linked to Learning Episode observational material to support emerging hypotheses about learning. A larger scale study involving more schools and conducted over several years could link the types of analysis undertaken in chapters 7 and 8 in a more systematic way than was possible in this thesis.

A major issue is the demonstration of variability which alerts teachers to, on the one hand the importance of factors working together, and on the other hand the clustering of outcomes. This is starting to erode a more mechanistic view of causality held by some teachers which has led some colleagues to suppose that there is 'a single solution' to 'a given problem'. Their professional development is starting to change in two important ways. First, they are assuming a more proactive role, being willing now to undertake experimental trial and improvement work in their class evaluating the outcomes on the basis of pupil learning. Second, the types of interventions undertaken are more likely to involve a developmental feedback loop rather than a full-frontal attack on an identified issue. For example, addressing the reluctance of certain groups of boys to read might involve raising motivation in other areas through role-play and games where reading is an incidental activity. Although these strategies have been used by teachers for some time, the Complexity Theory approach gives legitimacy to what might in the past have been considered 'a luxury which cannot be afforded in times of test score accountability'. Identifying and pulling the appropriate levers may be more effective than concentrating on a single factor. Teachers are also more likely to involve pupils in discussions about learning when they see the importance of comparisons of perceptions of learning across levels within the school. The upshot is the development of a new dialogue with teachers on their practice and on their own

and their pupils' learning. My own role is changing significantly from someone who might provide the answers from an external and 'expert' perspective to someone who assists in the building of learning capability. This transition is a slow process since it depends also on changes to teachers' attitudes and understanding. My approach has been to share insights and allow time for assimilation and accommodation of these. The findings in this thesis around the volatility and variability of performance data year on year is consistent with conclusions drawn by researchers within the School Improvement paradigm.

I have shared these developments with advisory colleagues and this is starting to influence the way we operate as a team. As might be expected, advisers are focused on finding strategies for raising pupil achievement and supporting the professional development of teachers. In the spirit of trial and improvement colleagues require evidence from the pilot work I have undertaken to convince them to adopt some of the strategies. However, many are willing to collect Learning Episodes for use with teachers and for an LEA-wide database. The use of the new representations of quantitative data developed in this thesis are also starting to influence discussions about schools and about the strategies to employ in supporting them. There is still a strong adherence to the inspection framework as a basis for judgements about effectiveness of schools and teaching among my advisory colleagues but this is becoming tempered as techniques for a more direct focus on learning are shared. I am introducing the idea of attractor states into discussions with advisory colleagues and suggesting they join me in exploring implications for designing programmes of support. This introduces the prospect of collecting a bank of Learning Episodes at adviser level which will record the 'evolution' of our own work with schools.

The Contribution of This Thesis to the Study of School Effectiveness and School Improvement.

The major contribution of this thesis has been to begin to develop a new type of dialogue between educational professionals using ideas drawn from Complexity Theory. This dialogue includes novel ways of collecting and analysing data and has implications for work on judging the effectiveness of and improving schools. The work done in this thesis widens the scope of the action research cycle to include techniques and insights inspired by Complexity Theory at each of the stages; Plan, Act, Observe, Reflect. In essence, a second learning loop which it has been suggested by Zuber-Skerritt [1996, p95] is essential for emancipatory change, has been applied to action research in the School Effectiveness and School Improvement context. This second loop is motivated by the success of Complexity Theory in other social contexts. A more detailed discussion of this claim is now presented below.

Although Fullan [1999], Clarke [2000] and Morrison [2002] discuss the relevance of Complexity Theory to education they do so from a philosophical perspective, applying Complexity concepts in particular to whole-school and to management issues. Morrison [2002] for example makes use of the Complexity Theory idea of 'fitness landscapes' to describe the management of change in schools. Byrne and Rogers [1996] use cluster techniques with quantitative pupil performance data at school level to investigate patterns of pupil selection. I believe that the work in this thesis is an attempt to assess the possible use of Complexity Theory at a pupil, teacher and school level. As such it also provides the opportunity to develop the work of advisory teams. The 'problem of operationalising Complexity Theory' has been directly addressed by attempting to develop instruments which are sensitive to concepts defined within this theory. In short, these include approaches to the use of quantitative and to qualitative data. The quantitative techniques include subject/gender comparisons and K-means clustering of variables, neither of which has been used elsewhere in education to my knowledge. The third technique, that

of measuring individual pupil progress and then collating these scores is becoming increasingly common and is not original to this thesis. In the domain of qualitative data the Learning Episodes drew on models of learning as discussed in the literature, however I use the model in an original way. Appreciative Inquiry is an established approach, however this, coupled with the Learning Episodes, the associated interviews and the Complexity inspired 'publication' of these in a Complex Adaptive space is entirely original. The further analysis of this qualitative data, the development of a typology and its refinement by linking with Social Activity Theory is also original, as is the experimentation with K-means clustering with the range of variables. I believe that the combination of these techniques and insights marks the beginning of an approach to school improvement and staff development which genuinely places learning at the centre. As such it provides a contrast with the official inspection framework as an evaluation model and complements the range of School Effectiveness and School Improvement approaches already in use. The electronic publication of data collected in multiple forms and at different stages of interpretation will allow teaching and advisory colleagues to forge their own reading paths through the material. The traces of their work with the data and further links and observations increase the data set and allow the possibility of evolutionary development.

Gray, Goldstein and Thomas [2003] argue that 'school improvement would appear to be characterised by bursts of activity over relatively short periods of time', and that consistent patterns may be discernable over short periods. They suggest that future inquiry might attempt to establish links between outcomes such as pupil results and rates of attendance and factors such as teaching styles and changes in leadership. In a recent professorial lecture, Barbara MacGilchrist [2003] explores the issue of variability of performance over time. Her recommendations are that the contextual factors in each school require careful consideration and that what is needed is a shift in focus from 'performance to learning'. The techniques developed in this thesis go some way to addressing both of these recommendations. The work of Gray et. al. and MacGilchrist cited above appears

to be an acknowledgement of the importance of more dynamic approaches to the study of school effectiveness. It is arguable that such dynamic considerations have been present in SESI research for some time. I believe, however, that my work in this thesis follows a distinctly different path. I now attempt to illustrate this with some comparisons.

Comparisons Between Current SESI Approaches and My Own Work

I have attempted to make comparisons between my own approach and some of the main strands in School Effectiveness and School Improvement. A comparison was made with a number of SESI approaches. I summarise just two of these below and have chosen the two which might have most in common with the use of Learning Episodes and an Appreciative Inquiry methodology. These are:

- Schools Must Speak for Themselves – John MacBeath
- Teacher-led School Improvement – David Frost and Judy Durrant

Schools Must Speak for Themselves – John MacBeath

John MacBeath and colleagues have developed an approach to school improvement which stresses the importance of self-evaluation. This is characterised by a long initial period of data-gathering through the use of a Self-Evaluation Profile (SEP) in focus groups of teachers, pupils, parents and governors. The SEP is designed to cover a range of school issues which SESI literature suggests are important for school improvement. Focus group members are expected to prioritise these issues and eventually settle upon a small number to become the project focus.

Much depends upon the quality of support for facilitating the focus groups and drawing the school towards a consensus. The role of a 'critical friend' is perceived as being a crucial one. This person not only guides the initial enquiry process in

focus groups but also assists in the collection of data that the school needs in order to make decisions, suggests strategies for implementation of improvement strategies and helps the school to evaluate the progress which has been made. Essentially the programme asks school communities to establish: a) What we believe is important in schooling b) How our school is performing against these important criteria. c) What, how and by whom should action for improvement be taken.

MacBeath et al [1999], emphasise the importance of the active participation of pupils, teachers and parents in establishing the aims for the school, identifying strengths and weaknesses and then in working for improvement. My own work is clearly within this vein and owes much to the self-evaluation approach. The study reported in this thesis would slot into the school improvement approach here since all participants are likely to identify learning as one principle aim. There are clear differences, however. In my work with Learning Episodes, I prioritised a focus on learning and did not move the participants towards a consensus position. I viewed it as important that judgements should remain half-formed and that there would always be the proviso that context is vitally important. This 'evolutionary' approach allows feedback to play a more central role and places more responsibility on school staff for improvement programmes.

Teacher-led School Improvement – David Frost and Judy Durrant

Teacher professional networks are a key element in some school improvement programmes. These have strongly influenced aspects of my work. The suggestion from Michael Fullan that 'School Improvement depends on what teachers think and do' is taken literally by colleagues at the Centre for Education Leadership and School Improvement CELSI. They argue that substantial change leading to school improvement must start with the concerns of those professionals at the centre of the educational process, the teachers. These colleagues must be guided through the process of 'reflective action planning' and implementation of their action

projects by those skilled in action research. In short it is important to establish a partnership between university or college researchers and teachers in school. Within this partnership teachers are supported through the following stages:

- 1) Identifying personal professional concerns
- 2) Developing an action plan: including details of inquiry strategies, time scales and dissemination strategies.
- 3) The development work itself, including evidence gathering and collaboration with other teachers.
- 4) Recording and documenting the activity
- 5) Reviewing the progress
- 6) Final preparation for professional accreditation and dissemination of the work.

(paraphrased from Frost, D. et al (2000), Teacher-led School Improvement, p 42)

Frost et al emphasise the importance of collaborative, critical reflection at all stages of the process, which is designed to increase the capacity of the teachers to know themselves and the school better and ultimately for the school to develop as an organisation. I was also attempting to build capability for reflection and change among teachers and took strategies from Frost et al to increase teacher collaboration. My approach, however, has much less commitment to an academic product. I saw it as part of my role to provide easy methods of recording instances of effective learning using the learning episode forms, teaching tips for the net and video clips. I also set guidelines for the collection of examples which is unusual in combination, although each might be selected from other work. I established the focus as learning rather than as performance and emphasised the collection of positive examples, at least initially although 'less positive' examples arose by implication. Viewing an example as positive did not imply a firm and final judgement but rather a half-formed judgement which could be revisited and modified. I attempted to move the agenda away from finality of judgement towards

a mind-set which emphasised continuous trial and improvement, where teachers (and pupils) saw it as more important to design better learning opportunities based on what they know at present rather than dwell too long on past successes and failures. I built in to the study ideas from Complexity Theory including a focus on local conditions (in this case for learning) along with an acceptance that general solutions would emerge rather than be planned in advance. Learning Episodes remain in 'design mode' rather than being converted into 'belief mode', (Bereiter [2002a]). They are therefore more accessible to teaching colleagues and available for immediate adaptation and use. Conversion of research findings into an academic product appears to reduce the appeal to other teachers.

A Comparison between Inspection reports and My Thesis

Shaw et al [2003], in a study of 3000 OFSTED inspections in secondary schools between 1992 and 1997, claim that for the bulk of schools no significant improvement in pupil results could be credited to the inspection process. In other words the process of evaluation and the writing and implementing of an action plan does not raise standards. They go on to quote the OECD [1995, p10] who claim that assessment of schools is best achieved by 'an unthreatening but demanding climate of self-review, in schools, so that they become 'learning organizations', capable of continuous improvement. This later approach has more in common with the work in this thesis than that of OFSTED or ESTYN. I was interested to explore the differences between my own work and the official inspection findings by comparing the ESTYN judgements with my own.

I have made a comparison between the latest official ESTYN inspections for each of the three schools and my own assessments based on the data collection and analysis processes described previously. For each school I have looked in detail at what I believe to be important omissions to a more complete picture of important dynamic processes within the school. For example, the school GL Inspection Report was published in October 2001. It acknowledges the high levels of

achievement of pupils in the school but does not highlight the exceptional amount of progress made by boys in English which is explained in the analysis of performance data section.

The percentage of pupils achieving level 4 or above for the NC tasks for 2001 in English, mathematics and science was significantly above the national average. Results compare well with those of similar schools, in particular with regard to mathematics and science. [school GL Inspection Report October 2001]

I have included an overall summary of the work here. Considering the experience of inspection in the three schools, quite apart from the emotional turmoil that ESTYN inspections cause, there is little evidence that the reports move the schools on. Clearly they do act as a sort of MOT to pick up any shortfalls in statutory provision or major problems with practice and pupil attainment. In the cases of these three schools whose results are either very good or satisfactory, the resultant reports miss much of the important detail and connections within and between levels which are vital to school development and improvement. In school GL, the inspection was largely irrelevant since the school has its own system of self-review. In school LL, the inspection reinforced structural changes which were in hand anyway. In school MA, the inspection invoked a state nearing complacency at management level if not in individual classrooms. This perpetuated a situation where collaboration, debate and reflection on effective learning was not encouraged among staff. It could be argued that the threat of imminent inspection convinces schools to undertake activities which then render the inspection unnecessary.

Did the Learning Episode approach provide any more impetus for school improvement than the inspection system criticised above? Probably not in the short time available for this study. In school GL the Learning Episodes augmented school self-reflection and added to teacher confidence as professionals. In school

LL, Learning Episodes were used as part of the official school self-evaluation report for inspectors but were largely sidelined by the inspection itself. In school MA the use of Learning Episodes has not really made any significant impact. The multi-stranded investigational approach including Learning Episodes, interviews and exploration of performance data does, I believe reveal more of the important mix of factors in each school.

I wish to make one other comparison here with a compilation report produced by Her Majesties Inspectors (HMI) in England. This involved visits to a number of schools, judged by individual inspections, to be doing very well and where pupils make better progress than the average. This Report [OFSTED, Oct 2002], focussed principally on the curriculum but linked successful pupil progress to other issues such as the role of the Headteacher and the educational environment. The spirit of the visits made by HMI and of the final report is investigational. It appears as though the framework for the visits was not fully worked out before hand and that the HMI were open to novel solutions judged against pupil learning. This spirit is rather closer to my own work than that of the formal inspection system.

Limitations of the work in this thesis

There are a number of limitations that need to be discussed here in terms of the way the project was conceived, methodology used and the collection and analysis of the data. I will address each of these in turn. The status of Complexity Theory is a question which might concern the critical reader of this thesis. It appears that I have invoked the use of Complexity Theory as a solution to perceived problems with more traditional SESI analyses. Some may claim that there is a danger here that interpretation may be 'forced' upon reluctant data because of some prior commitment to a theoretical framework. The framework itself grew out of attempts to organise data in a physical context and this often raises questions about transferability to social contexts. Work using Complexity Theory within social contexts elsewhere has, I believe, proved useful and places the theory on more

than a metaphorical footing. This may be a new paradigm, in Kuhnian terms, which is not yet sufficiently elaborated to displace alternatives (perhaps it never will). However I am convinced from reading elsewhere that this is an approach which deserves careful consideration in education. My project has involved attempting to locate empirical sites where Complexity Theory might have relevance and within these to pursue the most fruitful data collection strategies. The eventual outcomes of the work will depend on the usefulness of the instruments developed and the insights achieved. The limitations of this are obvious. Any attempt at generalisation would lack conviction. This was not an experimental design where some measurement of extent could be made. Perhaps this would be part of the next stage. Questions remain about whether all, some or any of the features of Complexity Theory have been identified. I believe I have established the case that some have and that the resultant insights appear to have useful practical applications. This may signal the success of an exploratory study?

Given that this is an exploratory study it is important to highlight some further limitations. It took the duration of the thesis to develop some of the instruments involved, and many will carry on evolving as I work further with teachers. In this regard there is little consistency in the data collection across the project. Neither was there an attempt to standardise work in each school, apart from visiting roughly the same number of classes and conducting the same number interviews across staff and students. Any quantification of the observation and interview data, therefore is largely heuristic, used to back up an emerging impression. As discussed in a previous chapter, there was no systematic attempt to match variables across the three schools and therefore no statistical justification for quantifying the coded sections. It is debatable whether future work would benefit from the application of more rigorous sampling methods across schools. Part of the argument in this thesis is that small initial variations can lead to radically different outcomes which mitigates against such an approach. In future projects I would endeavour to collect data from a greater number of schools to support the further identification of attractor states. Using as I did an Appreciative Inquiry approach

also means that there was an emphasis on the collection of what were perceived as positive examples of practice. I avoided attempts at 'balanced judgement' since this immediately raises the question of what framework is used to make judgements against. This also served to overcome what might have been a difficult tension between myself as researcher and as LEA adviser. The ultimate judgement is directed back to the pupils and practitioners who make a case for the learning. This approach of course invokes a self-fulfilling prophecy and precludes any definitive statement about what was or is. In short the work itself enters into a feedback spiral which carries it forward. I decided that far from being a drawback, this was an advantage of the whole approach since a key aim must be to improve my practice and assist teachers to improve theirs. The limitations, however, are that the work would not meet some of the standards of classical science. The validity of the work needs to be judged in terms of Action Research and of Complexity Theory where frequent feedback loops serve to correct initial impressions. The issue of anonymity of the schools involved also arose. In discussion with headteachers and teachers I decided to use initials to label the schools involved. The schools are readily identifiable from the contexts so full anonymity may be impossible.

Once collected the analysis of the data was also experimental. This was discussed extensively in the analysis chapter. The inferences drawn from the multiple representations of the quantitative data cannot be judged in terms of statistical significance. Apart from the type of analysis there was also the question of sample size. I did not expect to use measures of statistical significance and indeed it was such judgements that the early sections of the thesis contradict. The use of K-means cluster techniques in SPSS are an unknown quantity, however, I do try to compare this at one time with a manual method which at least allowed some insight into the process which the software undertook and suggested the future usefulness of the method with larger samples. The typology developed using the two axes Process – Content and Research – Adoption, remains to be further elaborated and developed since it emerged in the later stages of the thesis. This

will best be undertaken by reference back to teachers and their pupils. It does, however, reflect a pair of pervasive tensions which are particularly the concern of classroom teachers, on the one hand between whether to emphasise metacognition or behavioural objectives and on the other whether to organise more investigative learning activities or by demonstration and practice. In reality, teachers, and pupils wend their way through these polar possibilities without a major commitment to the extremities. My judgement in organising the data was about in which quadrant to place an event. The value in undertaking this work was that it highlighted differences between schools and across levels within schools. What was being attempted was the identification and classification of the 'learning climate' in each case. There are difficulties with relying on statements from interviewees since these can at times be designed to 'tell the interviewer what the interviewee thinks he wants to hear'. When used in conjunction with observational notes, as was the case with the events identified, the statements can be given credence.

The methodology employed in this thesis is influenced by Complexity Theory. The aim has been to collect and display data in multiple forms, to generate initial hypotheses and to publish these in such a way that participating professionals can read, amend and act upon these. This is close to the definition given by Hayles [1999] of hypertext as a Complex Adaptive System. The use of Complexity Theory within this context can be seen as strategic rather than as providing a theoretical model for the study of schools. Complexity Theory is unlikely to replace other, more traditional approaches but serves to complement them by providing tools to investigate the dynamic features of schools. There are a number of particular concerns with the data that have been mentioned before. The collection of data over time would allow a more dynamic picture to be formed. This will clearly be an important next step. I have particular regrets about not delving more deeply into the meaning placed on the word 'collaboration' by teachers, managers and by pupils since this is very closely tied to views of learning and might further elaborate the typology. Other issues arose around the use of Learning Episodes with teachers,

how these are published to motivate the interaction of practitioners with the material. These problems are still not resolved partly because of problems with website design. The use of Learning Episodes as interactive elements in a Complex Adaptive System has not so far fully materialised.

The new type of dialogue developing around my professional practice with teachers is novel in that it includes insights from the work above. Others have focused on learning, in fact many School Improvement programmes promote this as a prime concern. My work linking Complexity Theory, however, emphasises unpredictability, the importance of feedback and emergence and above all prioritises the in situ 'just in time' management of learning over that of detailed, step-by-step planning. This re-positions the learner at each level as the key player. The critical balance of too much and too little structure is justified within the Complexity framework which frees the practitioner to experiment and reflect on the outcomes by referring to what is learnt and how it is learnt. Responsibility in the management of learning, ones own and other peoples', passes from a detailed rehearsal of the steps of learning to the identification of feedback loops and appropriate levers. The manager is obliged to then influence learning by appropriate engagement in this cycle. The tools and instruments developed in this thesis assist in this process.

Implications and Future Developments

As intimated in the last section my professional practice is undergoing change as a result of this thesis. I will start by exploring further possible changes to my role and that of my advisory colleagues. I will also discuss implications for further research which I might undertake as a result of this thesis. Broader implications for school improvement and the management of schools stem from the adoption of a Complexity Theory perspective on education, these will be discussed briefly as a finale to the present project.

Some practical changes or additions to the range of performance data provided for schools would be valuable. Most LEAs are already establishing pupil-level databases to allow the tracking of pupil progress over time. This could easily be extended to provide an automated display of cross-subject comparisons at pupil and at school level and then split by other variables such as gender. An interesting comparison in larger schools might be that between parallel classes. In the same way, levels of pupil progress within and between schools would provide a valuable resource. Reflection by advisers and teachers on the yearly variations in subject/gender comparisons of performance data coupled with the collection of Learning Episodes will prove extremely useful in identifying effective teaching strategies.

An early paragraph in this thesis explained that the study was an explanatory one aimed, primarily, at investigating methodology for identifying and ultimately exploring the relevance of Complexity Theory in an educational setting. I also hoped to move on to establish some 'first draft' complexity models within this education context. To this extent the aims of the work have been realised, within the limitations outlined in the previous section. The most successful aspects of the thesis can be summarised as follows:

- a) A comprehensive description of the language of Complexity Theory and the use of examples drawn from an education context.
- b) The development of a non-judgemental, 'evolutionary' approach to the study of learning (compatible with Complexity Theory) within an educational setting.
- c) The analysis of views of learning at different levels within educational settings and a discussion of this in terms of self-similarity making comparisons with Complexity fractals.
- d) The 'first draft' description of two attractor states for schools.
- e) Exploration of the use of clustering techniques with qualitative and quantitative data in line with Complexity Theory inspired approaches utilised in other contexts.

The above points represent a contribution towards the operationalising of the Complexity Theory paradigm within an educational context. This has led further to:

- f) A discussion of the implications for educational organisations of the relevance of styles of planning and of appropriate focus at different levels within schools.
- g) Important changes in my professional practise when working with different schools.
- h) A starting point for the further development of my work as an adviser.

Further implications of this are discussed below.

Clustering techniques are unlikely to be as accessible to the majority of teachers and may initially be used by those with a particular interest. Clearly the role of advisers must include a large measure of the induction of the use of this information by teachers along with further experimentation and interpretation of the displays by advisers themselves. This training and support function would extend to a whole range of other issues which arise from this study. These include, ideas about feedback, involving pupils in discussions about learning, the role of conflict in learning, collaborative working and, in particular, ways of looking at and understanding learning. To a large extent this is developing as part of the work with teachers and Learning Episodes. I would see it as valuable for advisers to extend this reflective practice (or at least be more explicit about this reflection) to their own work. In short I foresee the role of adviser as becoming that of initiating and supporting action research programmes, their own and with teachers in schools, where the principles of evaluation and intervention include a large measure of Complexity Theory. In the spirit of Complexity Theory the practical strategy for achieving this may be to start with learning using an Appreciative Inquiry approach, as I have done in this thesis, rather than a theoretical introduction to Complexity Theory. In the longer term the advisory role will develop and change. Support and coordination of these action research activities including dissemination of findings across the LEA (and beyond) will always be an important part of this role. Perhaps the essential difference from the present role is that rather than acting upon an

assumed body of transferable knowledge about effective teaching (which has proved notoriously difficult to pin down), the adviser becomes a support agent for the creation and validation of local knowledge. As part of this supportive role the adviser assists in building the capability for learning within the school and within his/her own team.

It has long been claimed that one-day, In-Service events for teachers promote little change in practice. The adjusted role of the advisory service suggested above would be a step towards making 'continuous professional development' and 'the learning organisation' a reality. There are also important implications for school inspection. New frameworks for inspection in both England and Wales include provision for consulting pupils and for school self-review. Such self analysis, however, is to be undertaken against the inspection framework. I suggest that this does little to build learning capability in schools since it places the authority for the evaluation with an external agency. If a new role for advisers as outlined above were to be introduced there may still be a need to employ external inspectors to moderate the work and to provide external accountability. This could be a process of working with the school over a period of time to check on the progress being made by learners and the actions being put in place to promote this. Under such a regime the full school OFSTED or ESTYN inspection could be relegated to history.

A number of research activities are suggested as a result of this project. Perhaps the most interesting of these will involve the elaboration and use of the typology as has already been discussed. In particular I believe it will be valuable to investigate in more detail how participants at each level view learning at their own and other levels using the two dimensions, what was learnt and how it was learnt. This would help elucidate views on collaborative learning and allow a more detailed analysis of the distribution of authority. As indicated earlier, this might lead to a more refined view of the state of Complex Adaptation of the school. An insight of Complexity Theory suggests that there is an optimum state involving a carefully balanced level of structure and fluidity. Identifying such a state may assist schools in achieving it.

Further development of clustering techniques may lead to the identification of attractor states. The question then will be when and how do schools move between such states. Data collected over a period of time is required for such research. School Improvement can be viewed as stimulating the movement between attractor states. Work in this area should assist in identifying strategies for stimulating movement and enhancing the role of LEA adviser in the support of school improvement. It may also be useful to attempt a more systematic identification of the position of schools within the typology and in attractor states. What I envisage is a refinement of the typology and a strengthening of use of such a typology for understanding schools. Research of this nature may also lead to a fuller picture of school effectiveness. Skidmore [2003] claims that a new paradigm of assessment and learning with a 'Systems Thinking' emphasis is emerging from educational practice. Linking the strands of learning to professional practice of teachers and advisers as I have attempted to do in this thesis may assist in: '...developing a more sophisticated approach for transforming formative assessment data into information about schools and teachers.' [Skidmore, 2003, p77].

The question of studying dynamic systems is important and intriguing. Software such as STELLA, discussed in an earlier chapter, may assist in an education context as it has in business. The possibilities here require further thought. Early ideas include, the positive reinforcement experienced when learning is viewed in a particular way at each level, the interaction of views on what should be learnt and how and feedback relationships between levels of negotiation and the position of authority. There are large hurdles to be overcome with work in this direction. In order to use STELLA some quantification has to take place. This is clearly fraught with difficulty.

In a more practical vein there are a number of important implications for schools in adopting a Complexity viewpoint. Following on from the centrality of learning and feedback we might consider what types of planning are effective. If the system is to

be regarded as adaptive and flexible and many of the solutions emergent then this will be reflected in the planning; perhaps long-term vision and short-term adaptable practice. Time, perhaps the scarcest resource, can be moved from detailed long term planning to building up strategies for managing learning and working with dynamic systems. The fact that teachers may be an important element but not the key causal agent in promoting pupil learning might allow them to relax a little more into their role rather than feeling always at the centre of accountability. Certainly the act of putting learning at the centre and helping teachers to investigate what promotes learning is giving those in the study more confidence and feeling of control and professionalism.

Complexity Theory may provide a framework which complements established work in SESI, for example linking our present understanding of highly effective and 'failing' schools. To return to the analogy drawn at the beginning of this paper, the Newtonian Laws of Motion can be compared with reductionist models of school effectiveness. Both work satisfactorily in some situations but not in others. Finally, and this is in an increasingly speculative vein, is our school system in a lock-in state like that of the QWERTY keyboard discussed earlier? Are we locked into a way of teaching and organizing education which is prohibiting the evolutionary solutions to emerge? Would an understanding of this fact help release the constraints, as it were? Our universe can be considered as a linear system because the sun contains most of its mass and therefore dampens any chaotic tendencies. In this case the ensuing stability is a necessary condition for the development of life on earth. Most other organic systems, however, survive because of their ability to adapt and change. I suggest that there are interesting possibilities awaiting the application of complexity theories to the study of education.

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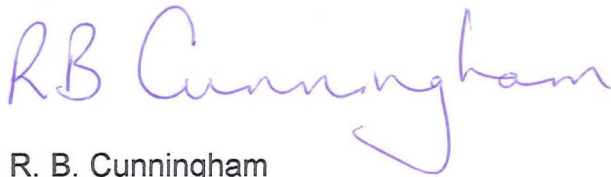
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An Exploration of the Potential of Complexity Theory for Addressing the
Limitations of Current Models of Change and Innovation in Educational
Practice.

I, Roderick Cunningham, declare that this thesis is all my own work.

Signed

A handwritten signature in purple ink that reads "R.B. Cunningham". The signature is written in a cursive style with a large, looped "C" at the end.

R. B. Cunningham
January 2004